Every scientific fulfillment raises new questions; it asks to be surpassed and outdated.

-Max Weber (d. 1920), Methodology of the Social Sciences

1.1 Introduction

The *Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish* was created to address the need for a timely re-evaluation of biological reference points for the New England groundfish complex. The 19 stocks comprising the complex (Table 1.4.1) are managed under the New England Fishery Management Council's Northeast Multispecies Fishery Management Plan (the 'groundfish plan'). Under this plan, overfishing definitions including biomass thresholds and limits and fishing mortality thresholds and limits are required and have been previously specified (Applegate et al. 1998; Table 1.4.2). The purpose of this study is to review the scientific adequacy of the existing overfishing reference points (biomass producing maximum sustainable yield, or Bmsy, and the fishing mortality rate associated with maximum sustainable yield, or Fmsy). It is appropriate to conduct this review now because there are significant new data and methodological improvements available to researchers with which to undertake such re-analyses (the specific conditions leading to this re-analysis are detailed in Section 1.5). Full terms of reference assigned to the group are given in section 1.3.

1.2 Working Group Membership

Membership in the working group was determined by two factors: (1) the need to include various species experts with specific information and experience in the stocks being considered, and (2) the desire to bring in independent scientists with no vested interest in the stocks being assessed, but with expertise both in the application of quantitative methods for reference point estimation and knowledge of the provisions of the Sustainable Fisheries Act (DOC 1996) and NMFS' guidelines for reference point development and control laws (DOC 1998; Restrepo et al. 1998). Accordingly, the following team of experts was assembled:

Experts from outside the northeast USA region:

Jim Armstrong
North Carolina Division of Marine Fisheries
Morehead City, North Carolina

Stratis Gavaris
Canadian Department of Fisheries and Oceans
St. Andrews, New Brunswick, Canada

Pamela Mace
National Marine Fisheries Service, Office of Science and Technology
Silver Spring, Maryland

Rick Methot
National Marine Fisheries Service, Northwest Fisheries Science Center
Seattle, Washington

Grant Thompson
National Marine Fisheries Service, Alaska Fisheries Science Center
Seattle Washington

Doug Vaughan, National Marine Fisheries Service
Beaufort, North Carolina

Experts from the NEFSC, Woods Hole, Massachusetts:

Jon Brodziak
Steven Cadrin
Chris Legault
Ralph Mayo
Steven Murawski - Chair
Loretta O'Brien
William Overholtz
Paul Rago
Fredric Serchuk
Michael Sissenwine
Mark Terceiro
Mike Sissenwine
Susan Wigley

Additionally, because the details of current reference points and the Council's interpretation of them and associated control rules was important to the deliberations, Council staff was requested to observe and present appropriate materials:

New England Fishery Management Council Observers:

Tom Nies
Steve Correia (Chair of the NEFMC's Multispecies Monitoring Committee) attended part-time

The full team met from 12-14 February in Woods Hole, Massachusetts to discuss approaches to the task, review preliminary data and analyses, and to develop a strategy for undertaking the required analyses and scheduling an expedited review procedure. Staff of the Northeast Fisheries Science Center (NEFSC) undertook the required data analyses and modeling studies. A draft copy of the final report was sent via regular and electronic format to the external panel members on March 8, 2002. The full panel developed comments which were submitted in writing on 15 March. The panel then met via conference call to discuss comments and agree on the final contents of the report. Because of the considerable number of analyses and large volume of data considered, this report is intended to provide updated reference points and graphical depictions of likely stock performance over the forecast periods. A full accounting of all data, methods and computer output is being developed into an associated technical appendix (currently being completed).

1.3 Terms of Reference

The terms of reference assigned to the working group were:

(a) assemble appropriate demographic, abundance, and fishery catch data with which to re-estimate biomass and fishing mortality rate thresholds and limits for 19 New England groundfish stocks covered in Amendment 9 of the Northeast Multispecies FMP,

(b) agree on appropriate projection methodology (estimates of vital rates and associated stochastic projection methods) with which to estimate maximum long-term yield and associated biomass and fishing mortality rate for the various stocks,

(c) revise estimates of Bmsy and Fmsy (or proxies), as appropriate,

(d) project stock status through 2009 relative to long-term biomass targets, and calculate fishing mortality rates necessary to achieve biomass targets by 2009 (if possible),

(e) comment on methods to estimate target fishing mortality rates for rebuilt stocks that will maximize yield while providing long-term average biomass at Bmsy.

1.4 Description of Current Reference Points

Important management reference points previously developed for the species comprising the New England groundfish complex are detailed in Tables 1.4.1 and 1.4.2. Specifically, these include estimates of Bmsy and Fmsy (or their proxies, depending on availability of data [Table 1.4.1]), and estimates of biomass thresholds for the various stocks. Maximum Sustainable Yield (MSY) has been estimated for all of the stocks in the complex, using a variety of analytical or heuristic methods (e.g., either the results of surplus production models, or catch averages over some specified historical period when the stock was judged to be in a relatively healthy condition). In most cases, for stocks with time series of catch (usually landings) and at least one fishery-independent abundance index, Applegate et al. (1998) undertook production modeling using the ASPIC (non-equilibrium) production modeling framework (Prager 1994; 1995). This method produced estimates of management parameters, their uncertainty, and allowed for projections of stock status assuming a fixed estimated intrinsic rate of population growth (r), and a stochastic version using uncertainty about the model fit. These predictions from ASPIC were used to assess potential re-building times for the various resources. Based on these analyses, the Council adopted 5-year and 10-year rebuilding time tables for resources judged to be in an overfished condition (NEFMC 1998; 2000). The Council also adopted estimates of threshold biomass, many of which, in retrospect, were inconsistent with the National Standard Guidelines because these biomass thresholds were specified below ½ Bmsy (Restrepo et al. 1998).

For a number of the stocks, where the results of surplus production models were judged to be either uninformative or unreliable, a multi-stage process for developing biomass and fishing mortality rate proxies and MSY was undertaken (e.g. Gulf of Maine haddock, Mid-Atlantic yellowtail flounder, etc., Table 1.4.2). The biomass proxy was selected as an average or quantile of the research vessel survey indices over some period when the stock was determined to be capable of producing relatively high and stable catches (i.e., the MSY proxy). This was set as Bmsy, and either 1/4 or ½ of this value was chosen as the biomass threshold. For fishing mortality rate proxies, a simple quotient of the annual landings L_t divided by the annual research vessel biomass index value (I_t) was proposed as a relative fishing mortality rate:

$$relF_t = L_t / I_t$$

Taken as a time series, this index should be sensitive to changes in landings with respect to underlying biomass, and vice-versa, thereby indexing fishing mortality. Important assumptions of the method are that the catch (e.g. landings) series is a consistent measure of the force of exploitation (e.g., changes in the discarding vs. landings patterns are minimal) and that the age/size groups included in the biomass index are appropriate to those groups represented in the catch. As a practical matter, no adjustment of the research vessel survey indices for pre-recruit size fish were made, but this is generally thought to be a minor effect since *per capita* weight of pre-recruits is substantially less than that of exploited sizes caught in the surveys. Proxies of Fmsy based on relF were developed by examining the time series of relF in relation to landings to approximate periods when the stock was relatively large, landings were stable, and relF was moderate (in the context of the particular time series). The actual reference points were specified as the running average of relF (usually for three years) owing to the noise inherent in these un-smoothed metrics derived from annual research vessel indices. No methods for forecasting or prediction were previously proposed to account for the effects of regulation on the stocks managed under biomass and relF proxies.

1.5 Background and Need for Reference Point Re-Evaluation

Prior to the Sustainable Fisheries Act of 1996, New England groundfish were managed according to various overfishing definitions. Amendment 4 of the Northeast Multispecies Plan (1992) specified overfishing definitions of $F_{30\%MSP}$ for Georges Bank haddock, and $F_{20\%MSP}$ for other stocks. A national review including Amendment 4 overfishing definitions concluded that biomass thresholds were needed, and some of the fishing mortality rate overfishing definitions specified in Amendment 4 were greater than F_{MSY} (e.g., Gulf of Maine cod, Georges Bank cod, Georges Bank haddock, Gulf of Maine haddock, redfish; Rosenberg et al. 1994). Amendment 7 (1996) specified $F_{0.1}$ as an overfishing reference point for all principal groundfish stocks (Gulf of Maine cod, Georges Bank cod, Georges Bank haddock, Georges Bank yellowtail, and southern New England yellowtail), and spawning stock rebuilding targets for Georges Bank cod (70,000 mt), Georges Bank haddock (80,000 mt), Georges Bank yellowtail (10,000 mt), and southern New England yellowtail (10,000 mt). These first estimates of biomass rebuilding targets were specified as minimum spawning biomasses deemed necessary to avoid lower recruitment stanzas (higher probabilities of recruitment failure) rather than biomasses that would be necessary to generate the maximum sustainable yield of these stocks. Passage of the SFA in would subsequently require the latter.

In 1997, The New England Fishery Management Council (NEFMC) formed an Overfishing Definition Review Panel to recommend biological reference points for consideration as overfishing definitions in conformance with the SFA (Applegate et al. 1998). The Panel reviewed existing reference point estimates, analyzed biomass dynamics, and recommended MSY reference points or proxies for all northeast groundfish stocks. The Panel used three basic methods to derive MSY reference points or their proxies for the nineteen groundfish stocks considered in this report: 1) biomass dynamics models for ten stocks (Gulf of Maine cod, Georges Bank cod, Gulf of Maine haddock, Georges Bank yellowtail, southern New England yellowtail, Cape Cod yellowtail, witch flounder, southern New England winter flounder, Georges Bank winter flounder, and white hake); 2) dynamic pool models for five stocks (i.e., $F_{MSY} = F_{0.1}$ or $F_{20\%}$, and B_{MSY} is a function of average recruitment or a MSY proxy; Georges Bank haddock, American plaice, redfish, Pollock, and halibut); and 3) survey proxies of biomass and exploitation ratios from periods presumed to produce relatively large sustainable yields. Estimates of B_{MSY} for nearly all stocks were similar to biomass estimates or survey indices observed in the 1960s. The fact that Bmsy values were within the range of observed biomasses was due to the tendency of biomass dynamics models to estimate within this range, was an implicit outcome of the choice of observed average recruitments for dynamic pool methods, or explicitly as the chosen period for survey proxies. For the principal groundfish stocks, estimates of B_{MSY} were substantially greater than the Amendment 7 rebuilding targets (e.g., 108,000 mt total biomass of Georges Bank cod; 105,000 mt spawning biomass of Georges Bank haddock; 49,000 mt total biomass of Georges Bank yellowtail, and 51,000 mt total biomass of southern New England yellowtail). Although MSY reference points for most of these stocks were updated through peer reviews (e.g., the Northeast Stock Assessment Workshop [SAW], or the Transboundary Resources Assessment Committee) from 1998 to 2000, the methodology for estimation was not revised.

The NEFMC formed the Groundfish Overfishing Definition Committee in 2000 to address concerns about MSY reference points, including the reliability of biomass dynamics models for deriving overfishing definitions (NEFMC 2000). The Committee concluded that many of the production models for groundfish stocks need to be updated with more comprehensive approaches. In 2001, the Gulf of Maine cod assessment and production modeling in general were externally reviewed by the 33rd SAW (NEFSC 2001c). With respect to production modeling, the workshop concluded that age-based production models should be applied to many groundfish stocks, because age-based information is available for many, stocks may be far from equilibrium, and that predictions from age-based models for the purposes of estimating rebuilding schedules was likely better accomplished through techniques that could incorporate recruitment dynamics explicitly.

This Working Group adopted many of the recommendations of SAW33 for completing its terms of reference. Therefore, age-based production models were developed for stocks with time series of age-structured assessment information, and reviewed age-based production models as candidate methods for estimating MSY reference points.

The historical development of overfishing definitions for New England groundfish reflects changes in national standards as well as advances in technical methodology.

In the intervening period since the NEFSC adopted its various biomass and fishing mortality targets and thresholds, a number of technical limitations of the various estimation approaches have emerged. First, for most of the stocks currently assessed with age-based stock assessment models (e.g. VPA, table 1.4.1) the biomass and F reference points were determined in weight-based units using ASPIC. This has created some difficulties and confusion regarding the interpretation of annual status of resources, and in projecting stock performance under mandated recovery plans. For example, the fishing mortality rate reference points (Fmsy) estimated in ASPIC are biomass weighted, meaning that they assume the full force of mortality over all age groups included in the tuning indices and catches. This is as opposed to a typical age-based assessment that estimates the partial recruitment (selection) at age and monitors the fishing mortality rate averaged over just the age groups determined to be fully-represented in the catch. When large but partially recruited year classes enter the fishery, the biomass-weighted fishing mortality rate may change in relation to the dominance of these partially selected fish, which cannot be determined independently in the assessment method. Thus, assessment scientists have had to convert fully-recruited fishing mortality into biomass-weighted fishing mortality rates in order to provide advice on the annual fishing mortality rates in relation to Fmsy. Changes in the biomass weighting have resulted in a "moving target" for managers owing to the effects of year class variations, and having little to do with the underlying fishing mortality on fully selected age groups. This problem is described in more detail in the methods development section of NEFSC (2001c). These difficulties in interpreting biomass-weighted reference points using age-based assessments, caused the Northeast Stock Assessment Review Committee (SARC) proposed new reference points to be calculated based on consistent age-based methods. These were recently calculated for Gulf of Maine cod and redfish (NEFSC 2001c).

A second issue related to the current reference points is the tendency of surplus production methods to estimate MSY and Bmsy within the observed ranges of the data, irrespective of the exploitation histories of the various resources. Many of the fishery resources of the Northeast region have been heavily exploited and overfished (both growth- and in some cases recruitment-overfished), for decades. For example, Georges Bank haddock were overfished with significant discards of young fish beginning in the 1910s (Herrington 1932; Clark et al. 1982). Landings data representing the 70 year documented exploitation history probably do not represent the true production potential of this and other resources, because of the high fishing mortality rates and poor selection patterns. Thus, if production models estimate Bmsy as some average or quantile of the biomass time series, this estimate may under-represent the real biomass potential of a well-managed stock, thereby setting the target biomasses and the expectations of managers at too modest a level.

A recent example of this situation is instructive. Atlantic sea scallops were significantly growth overfished for many years, with strong year classes depleted quickly and landings and stock sizes fluctuating significantly over time. Because of the chronic growth overfishing scenario, the Overfishing Definition Review Panel (Applegate et al. 1998) recommended that the biomass targets be set at levels that *should be realized* if the stock were fished consistently with mortality

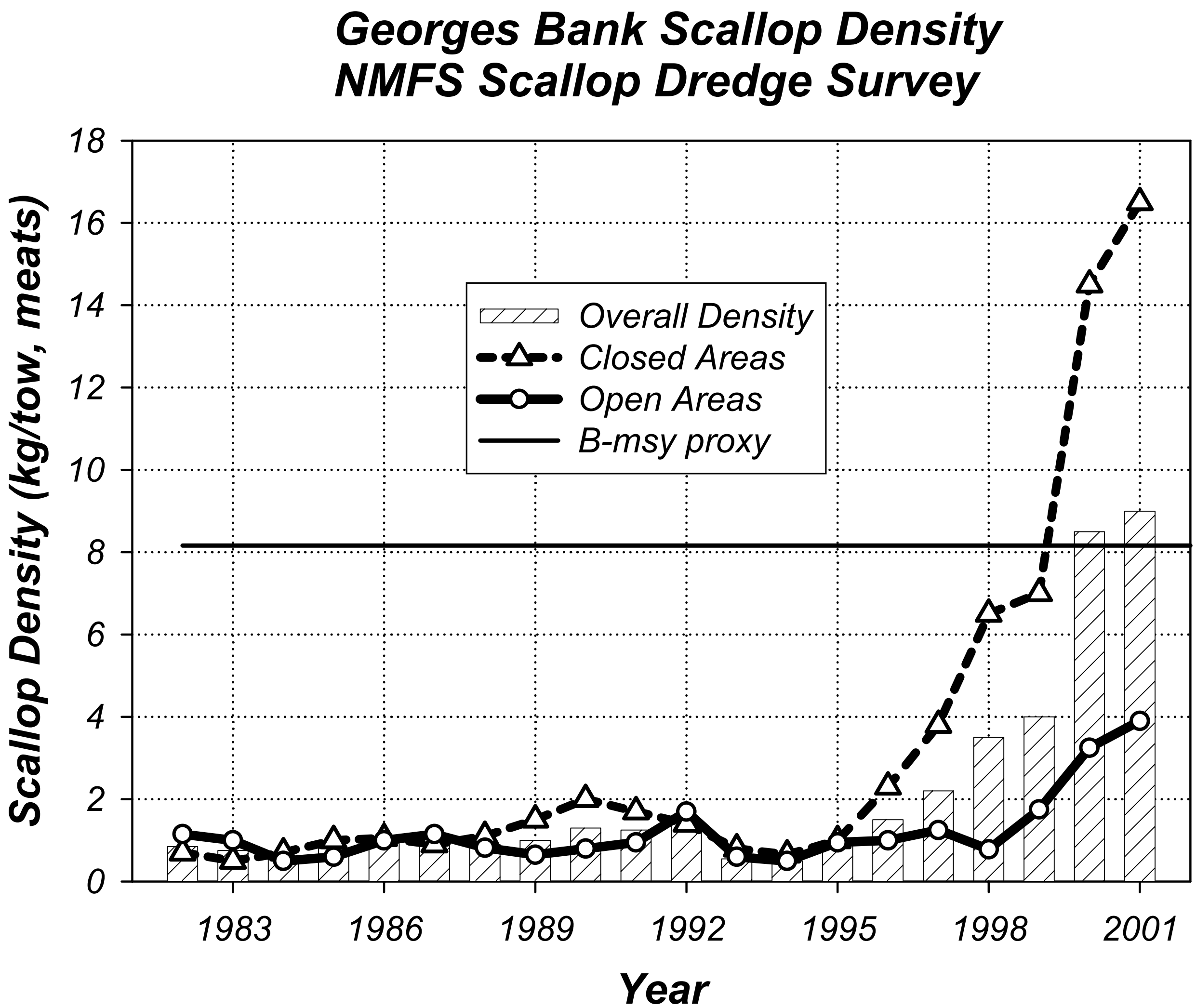

Figure 1.5. Relative sea scallop biomass on Georges Bank, 1982-2001. Data are the average scallop biomass indices (calculated meat weight per dredge tow) for open and closed areas and the USA portion of the Bank as a whole. The B-msy proxy of 8.16 kg/tow is given. The proxy was calculated by multiplying the median recruit index of 99.9 recruit-sized scallops per tow by the expected biomass per recruit of 81.6 g associated with fishing at Fmax. Areas were closed On Georges Bank beginning in late 1994.

set at Fmax. The panel developed a biomass proxy based on the median recruitment (in survey units) observed over the time series of scallop dredge surveys multiplied by the biomass per recruit that would be obtained if the stock were fished at Fmax. The resulting target was more than three times the highest biomass index ever seen in the survey to that time (Applegate et al. 1998, page 148). Owing to significant reductions in harvest rates due to effort cuts and closed areas, combined with strong recruitment, the biomass of Georges Bank scallops has recently surpassed the biomass target developed by the panel (Murawski et al. 2000; Figure 1.5). In this example, the biomass series from the surveys was not considered an informative time series from which to draw inferences about the proper level of Bmsy (e.g., the actual biomass potential of the stock was never observed because of chronic overfishing). Thus, if surplus production modeling methods seek Bmsy by inferring equilibrium conditions occurring within these series, then there is an inherent bias to underestimation of Bmsy and likely overestimation of Fmsy. As noted above, there are significant concerns that biomass targets developed to date for the New England groundfish resource are too low relative to the true production potential of properly fished resources.

Several other issues have also prompted interest in re-estimation of the reference points for these and other resources. The National Research Council's reports on *Improving Stock Assessments* (National Research Council 1998a) and its *Review of Northeast Fishery Stock Assessments* (National Research Council 1998b) both emphasized that when estimating management parameters, a wide array of candidate models and approaches should be evaluated, so as to improve understanding of the processes involved and to allow for corroboration of approaches. Similar issues were raised by Crecco (2002) in his memorandum related to the choice of stock-recruitment models for biomass and F reference point estimation, and reviewed by this Working Group. Also, since the first Overfishing Definition Review Panel met, the final guidelines for the SFA were issued by NMFS. The existing overfishing definitions need to be re-considered in light of the revised guidelines and the practical experience that has been gained in their use. There are significant new data on stock status, particularly related to recovering stocks and the conditions associated with those recoveries (e.g. Georges Bank haddock and yellowtail flounder and to a lesser degree other species in the groundfish complex) that may shed light on the estimation of proper management targets and thresholds. Given these changes in stock status, and the requirement to rebuild stocks to Bmsy by 2009, new projections of the fishing mortality rates required to meet these targets are needed by managers. Last, the methods used to define management reference points for index-level species do not include a method to project stock status and rebuilding. There is a need for methodological development in this area, and approaches to this problem need to be developed.

For the reasons stated above, re-estimation of the basic reference points for groundfish management was considered a priority issue.

1.6 Organization of Data and Analyses to be Undertaken

This report is organized into three sections: descriptions of models and quantitative approaches to reference point estimation and prediction methods, analysis of the reference points for each of the 19 stocks covered in Amendment 9, and a general section related to the conclusions of this work. Numerical data and full computer output from all analyses described herein will be included in a companion technical appendix (section 7); such data are too voluminous to be included in this summary report.

The section on *Estimation and Projection Methodology* describes the multiple approaches used for the various stocks, and is primarily sorted on the three types of data generally available for the stocks considered. For stocks with full age-based model estimates of stock, recruitment and biomass per recruit, multiple approaches to describing the relationship between stock and recruitment are evaluated. In this regard, nearly two dozen potential stock-recruitment functional form were evaluated for the various stocks. Some objective model diagnostics were developed and applied to all candidate models for the purposes of model comparison.

A model-free (empirical non-parametric) approach was developed for comparison with parametric stock-recruitment (s-r) model approaches, and also used for stocks where s-r models could not reliably be fit to data. This approach applied various moments of the observed recruitment series and expected biomass per recruit to estimate the theoretical spawning biomass expectation associated with fishing at various F reference levels. This approach was used as a semi-independent check of s-r model results and as a basis for inferring the bounds of likely biomass had stocks not been growth overfished (e.g., see the scallop example cited in section 1.5). For stocks where the non-parametric approach was used to estimate Bmsy, the default F proxy of F40% msp was chosen as a robust reference point, based on several meta-analyses of spawning potential associated with sustainable fisheries (Clark 1991; Clark 1993). For Acadian redfish, an F proxy of 50% msp was chosen based on specific meta-analyses of similar west coast species (Dorn 2002).

Index-based methods for reference point estimation are considered in light of the specific goal of identifying the limit relative fishing mortality rate (relF) that is associated with stock replacement, in the long term. Biomass and catch data are used to develop these relationships, and the robustness of the approach is evaluated with some proposed test statistics.

Existing biomass and fishing mortality rate targets for all 19 stocks (a 20^{th} stock, Gulf of Maine winter flounder is not evaluated in either the former review or this update) are re-considered in light of the quantitative approaches. Where appropriate, recommendations on revised management parameters are given. In each species section predictions of stock status, biomass and catch are given for the period from the current year (2002) to 2010 . The probabilities of achieving the proposed revised management targets are evaluated under the revised Fmsy value. If there is not at least a 50% chance that the stock will recover to the Bmsy value by 2009, the maximum F level allowing a 50% chance of recovery is calculated.

In the last section of this report, the information on revised reference points is summarized in light of the various approaches and data. For some of the species considered herein, proposed Bmsy values are larger than those previously estimated (although in most cases the existing and proposed biomass targets cannot be directly compared due to the differences in measurement scales [e.g., total vs. spawning stock biomass]). This naturally leads to the question, considering potential multispecies interactions, is it feasible to restore all the major components of this resources to Bmsy simultaneously? Some data and analyses and previous studies germane to this question are considered.

The primary task at hand is the re-estimation of *long-term* biomass and fishing mortality rates for this complex of species. The critical component of all of these analyses is the course of future recruitment to the stocks. In the Northeast region there is clear evidence that larger spawning stocks associated with stock rebuilding give higher odds of producing larger year classes (Brodziak et al. 2001). However, there is substantial variability around the relationship between parental stock size and subsequent recruitment, and the functional form of that relationship is elusive (hence the nearly two dozen candidate forms evaluated herein). We have purposely not considered management tactics in light of short-term recruitment prospects, and specifically approaches to managing depleted stocks for which recent recruitment has been well below average. It is possible that these stocks cannot meet long term targets without recruitment that will rarely occur even if fishing is stopped. These issues are simply beyond the scope of the current study.

Table 1.4.1. Common and scientific names, stock definitions, and assessment types and lengths of assessment time series for 19 stocks regulated under the Northeast Multispecies Fisheries Management Plan of the New England Fishery Management Council. Assessment types are: VPA = age-based assessment using catch and survey data, surplus production = age-aggregated analyses using catch and survey data, Index = survey indices and catch data.

Common Name	Scientific Name	Stock Unit	Assessment Type / Period
Atlantic Cod	*Gadus morhua*	Gulf of Maine	VPA - 1982+
		Georges Bank	VPA - 1978+
Haddock	*Melanogrammus aeglefinus*	Gulf of Maine	Index - 1963+
		Georges Bank	VPA - 1931+
Yellowtail Flounder	*Limanda ferrugineus*	Georges Bank	VPA 1973+
		S. New England	VPA 1973+
		Cape Cod	VPA 1985-1998
		Mid-Atlantic	Index 1967+
Winter Flounder	*Pseudopleuronectes americanus*	Georges Bank	Sur Prod. 1964+
		S. New England	VPA 1982-1998
American Plaice	*Hippoglossoides platessoides*	Gulf of Maine-Georges Bank	VPA -1980+
Witch Flounder	*Glyptocephalus cynoglossus*	Gulf of Maine	VPA 1982-1998
Acadian Redfish	*Sebastes fasciatus*	Gulf of Maine	VPA 1963+
White Hake	*Urophycis tenuis*	Gulf of Maine-Georges Bank	Surplus Production 1964+
Pollock	*Pollachius virens*	Gulf of Maine-Georges Bank	VPA 1971-1993
Ocean Pout	*Macrozoarces americanus*	S. New England	Index 1968+
Windowpane Flounder	*Scophthalmus aquosus*	Northern	Index 1963+
		Southern	Index 1963+
Atlantic Halibut	*Hippoglossus hippoglossus*	Gulf of Maine	Index - 1963

Table 1.4.2. Current estimates of biological reference points for stocks managed under the Northeast Multispecies Fishery Management Plan (note that no revision is provided for Gulf of Maine winter flounder)

SPECIES	STOCK	STAT. AREAS	ESTIMATED REFERENCE POINTS				SOURCE OF ESTIMATE
			B_{TARGET} (metric tons)	$B_{THRESHOLD}$ (metric tons)	F_{MSY}	MSY (metric tons)	
COD	GB	520-600	108,000	27,000	0.32	35,000	Amendment 9 to the NEMS
	GOM	510-515	90,300 (total) 78,000 (ssb)	45,150 (total) 39,000 (ssb)	0.23	16,100	SAW - 33
HADDOCK	GB	520-562	105,000[1]	53,000	0.26	NA	Amendment 9 to the NEMS
	GOM	510-515	8.25 kg/tow[2]	2.06 kg/tow[2]	0.29(C/I)[3]	2,400	Amendment 9 to the NEMS
POLLOCK		441-616	102,000[1]	26,000[1]	0.65	40,000	Amendment 9 to the NEMS
REDFISH		500-562	121,000	60,500	0.116	14,000	Amendment 9
WHITE HAKE		Areas 5+	14,700	7,350	0.29	4,200	SAW - 33
YELLOWTAIL FLOUNDER	GB	522,525, 551,552, 561,562	43,500	21,750	0.33 (biomass weighted)	14,100	TRAC 2001
	SNE	526, 537-539	51,000	12,800	0.23	11,700	SAW - 27
	Mid-Atl.	600s	9.15 kg/tow[2]	4.58 kg/tow[2]	0.36(C/I)[3]	3,300	Amendment 9
	Cape Cod	514, 521	6,100	3,050	0.4	2,400	SAW - 28
WINDOWPANE FLOUNDER	Northern	Area 5 except:	0.94 kg/tow[2]	0.47 kg/tow[2]	1.11(C/I)[3]	1,000	Amendment 9
	Southern	526, 530-539, 541, Area 6	0.41 kg/tow[2]	0.10 kg/tow[2]	2.24(C/I)[3]	900	Amendment 9

WINTER FLOUNDER	GB	522, 525, 551-562	2.49 kg/tow[2]	1.24 kg/tow[2]	1.21 (C/I)[3]	3,000	SAW - 34
	GOM	510-515	*No recommendation*			2,000	
	SNE/MA	521, 526, 537-539, 600s	27,810	6,952	0.37	10,220	SAW - 28
AMERICAN PLAICE		Areas 5+	24,200[1]	6,050[1]	0.19	4,400	SAW - 28/SAW - 32
WITCH FLOUNDER		Areas 5+	25,000	10,500	0.106	2,684	SAW - 29
ATLANTIC HALIBUT		Areas 5+	5,400	2,700	0.06	300	Amendment 9
OCEAN POUT		Areas 5+	4.9 kg/tow[2]	2.4 kg/tow[2]	0.31(C/I)[3]	1,500	Amendment 9

1] Biomass level based on spawning stock biomass (SSB) not total biomass

2] Reference points expressed in nominal survey units rather than total stock biomass because the model estimate of the catchability coefficient could not be verified. F_{msy} based on relative exploitation index

3] Relative exploitation index (catch/survey index)

4] B_{msy} calculated from F_{msy} proxy and estimate of MSY