Fish Stocks in Rebuilding Plans: A Trend Analysis

Introduction

The control of fishing mortality (F) is essential to rebuilding stocks that have been overfished. The Magnuson-Stevens Fishery Conservation and Management Act (sec. 304(e)(4)) mandates the National Oceanic Atmospheric Administration (NOAA) and the National Marine Fisheries Service (NMFS) to end overfishing immediately and to rebuild stocks in as short a time as possible, not to exceed 10 years, except where circumstances dictate otherwise. Overfished stocks can rebuild when overfishing is ended and favorable environmental conditions increase biomass (B). Rebuilt stocks offer a sustainable and stable seafood supply for fishermen and consumers.

Understanding how total mortality, including F, affects B is essential to rebuilding an overfished stock. Rebuilding of a stock will generally occur if more fish survive to maturity. There are several types of mortality including natural and fishing mortality. Natural mortality, such as through predation, occurs regardless of management control. Fishing mortality (F) can be directly controlled through the management measures recommended by Regional Fishery Management Councils (RFMC) and approved and implemented by NOAA. Management measures to protect essential fish habitats may also help to increase the survival of stock members at critical life stages where natural mortality is higher than at other life stages.

Using the best available science, rebuilding plans are developed by the RFMCs and approved by NMFS to control F so that a stock can rebuild to sustainable levels. When F is controlled, more members of the stock can survive and spawn, thus increasing the probability of a stock rebuilding. NMFS conducts stock assessments to determine the current levels of F and B for the stock, and to estimate, or re-estimate, sustainable values of F (F_{MSY}) and B (B_{MSY}) levels for each stock. Rebuilding plans use these values to predict the time it will take for B to rebuild. Generally, where F is less than F_{MSY}, B will increase, approaching B_{MSY}. However, there are cases where controlling F does not result in increased B. There are several reasons rebuilding may not occur. Biomass is affected by a number of factors in addition to fishing, including habitat loss, environmental variability, and community dynamics such as disease outbreaks and predator-prey interactions. If these factors are not accounted for in the rebuilding plan, it may take longer to rebuild the stock than anticipated; therefore, control of F is necessary for rebuilding, but cannot guarantee rebuilding.

Methods

Trends in B and F can demonstrate a rebuilding plan's progress in achieving targets for overfished stocks. NMFS reviewed 65 stocks that have at one time been declared overfished (Table 1) to determine if they were candidates for inclusion in a trends analysis. This analysis included stocks that are currently not overfished, but are still rebuilding. NMFS examined B and F trends in relation to a stock's biological reference points (B/B_{MSY}, F/F_{MSY}). The latest stock assessment data were used to create figures of a stock's trends prior to and following an overfished declaration. Due to the periodic recalculation of F and B by stock assessment scientists, in many figures, the initial estimates of F and B used in the overfished declaration are

included to illustrate the uncertainty of stock assessment estimates. These initial estimates of F and B are from the last data year used in the assessment and may not necessarily be the same year the stock was declared overfished; in most cases, it precedes the overfished declaration year by a year or two. Many stocks have been in rebuilding plans prior to the Sustainable Fisheries Act of 1996 (Table 1) but these initial estimates do not appear in the figures; only estimates for the current rebuilding plan are in this analysis.

There are several reasons why some of the (65) stocks were not appropriate for the NMFS analysis. Nine of these 65 stocks were not included in the analysis because they are not in rebuilding plans for the following reasons: 1) the stock has been recently declared overfished, so a rebuilding plan has not yet been implemented; 2) the stock has insufficient data to develop a rebuilding plan; 3) A formal rebuilding program was not submitted under the MSA[1]; and 4) A rebuilding plan is not required. An additional 17 stocks are in rebuilding plans, and were not included in the analysis for the following reasons: 5) the rebuilding plan has only recently been adopted and the most recent scientific assessment does not yet reflect its measures; and 6) the stock does not have reliable estimates of biomass and/or fishing mortality. The remaining 39 stocks were considered appropriate for the analysis and their F status and B trends are shown in Table 2. Four of the stocks in the analysis have now been rebuilt.

Results and Discussion

Using data from the most recent stock assessment, figures were created to illustrate the trends in F and B for the 39 stocks. For most stocks, this time series extends to four years prior to the overfished declaration. The control of F was evaluated prior to the categorizing of the B trends for each stock. For this discussion, F is considered controlled if it is reduced to or is kept under the overfishing level ($F/F_{msy} <1$). If F is controlled, one would expect B to increase if conditions are favorable; therefore we evaluated the recent trends based on two criteria: B is increasing or B is not increasing.

In many cases B showed no clear trend in biomass or the biomass is at a standstill. These stocks, such as windowpane flounder, are included in the *"B is not increasing"* category. In other cases, B showed no clear trend until the final years of the analysis, when slight upward trends were discernable. In these cases – such as with widow rockfish – Pacific coast or cowcod - Southern California – the stocks were deemed to have B increasing.

Of the 39 rebuilding stocks that were evaluated for fishing mortality trends, 29 stocks (74%) had F controlled by the end of the time series (Table 2). For these 29 stocks, 23 stocks (79%) show increases in biomass and 6 stocks (21%) show declines or flat trends in biomass. For the 10 stocks where F has not been adequately controlled, 8 (80%) show declines or flat trends in biomass. These results demonstrate the importance in controlling F in order to achieve rebuilding.

[1] Applicable to Atlantic salmon only - a Final Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon has been developed under the ESA.

Regional Reviews

The Northeast (NE) region has 21 stocks in rebuilding plans that were evaluated. Of these, 14 (67%) have successfully controlled F during the available time series. Of those 14 stocks, 11 (79%) are rebuilding biomass; 3 of these 14 stocks have now fully rebuilt (bluefish - Atlantic Coast, monkfish – Gulf of Maine/Northern Georges Bank, and monkfish – Southern Georges Bank/Mid-Atlantic). Of the 7 overfished NE stocks where overfishing was occurring, all 7 (100%) have declining biomass.

Northeast Region				
Stock	**F Controlled/ Biomass Increasing**	**F Controlled/ Biomass Not Increasing**	**F Not Controlled/ Biomass Increasing**	**F Not Controlled/ Biomass Not Increasing**
American plaice - Gulf of Maine / Georges Bank		√		
Barndoor skate - Georges Bank / Southern New England	√			
Bluefish - Atlantic Coast	√			
Atlantic cod - Georges Bank				√
Atlantic cod - Gulf of Maine				√
Tilefish - Mid-Atlantic Coast	√			
Haddock – Georges Bank	√			
Haddock – Gulf of Maine	√			
Ocean pout - Northwestern Atlantic Coast		√		
Pollock - Gulf of Maine / Georges Bank	√			
Acadian redfish - Gulf of Maine / Georges Bank	√			
Spiny dogfish - Atlantic Coast	√			
Summer flounder - Mid-Atlantic Coast	√			
Thorny skate - Gulf of Maine				√
White hake - Gulf of Maine / Georges Bank				√
Windowpane - Southern New England / Mid-Atlantic		√		
Winter flounder - Southern New England / Mid-Atlantic				√
Yellowtail flounder - Cape Cod / Gulf of Maine				√
Yellowtail flounder - Southern New England / Mid-Atlantic				√
Monkfish - Gulf of Maine / Northern Georges Bank	√			
Monkfish - Southern Georges Bank / Mid-Atlantic	√			
Percentage of Stocks in Category	53%	14%		33%

The Southeast (SE) region has 3 stocks included in this analysis. Of those three, overfishing is controlled in 2 stocks. Red porgy - Southern Atlantic Coast, where overfishing ended in 2000, is rebuilding biomass; king mackerel – Gulf of Mexico is now fully rebuilt. However, despite ongoing overfishing, greater amberjack - Gulf of Mexico continued to build biomass every year after the overfished declaration in 2001, except for 2005.

Southeast Region				
Stock	**F Controlled/ Biomass Increasing**	**F Controlled/ Biomass Not Increasing**	**F Not Controlled/ Biomass Increasing**	**F Not Controlled/ Biomass Not Increasing**
Greater amberjack - Gulf of Mexico			√	
King mackerel – Gulf of Mexico	√			
Red porgy - Southern Atlantic Coast	√			
Percentage of Stocks in Category	67%		33%	

The seven Northwest (NW) region stocks in this analysis have both controlled overfishing and have increasing biomass. Most of the NW region stocks are long-lived fish and biomass rebuilds slowly; therefore the rebuilding plan periods are protracted. The cowcod – Southern California is estimated to rebuild biomass over a 39-year period. Despite the slight apparent increase in biomass in the figure, the cowcod has increased B/B_{MSY} from 0.056 at the overfished declaration to 0.094 at the end of the time series, an increase of 68%.

Northwest Region				
Stock	**F Controlled/ Biomass Increasing**	**F Controlled/ Biomass Not Increasing**	**F Not Controlled/ Biomass Increasing**	**F Not Controlled/ Biomass Not Increasing**
Bocaccio - Southern Pacific Coast	√			
Canary rockfish - Pacific Coast	√			
Cowcod - Southern California	√			
Darkblotched rockfish - Pacific Coast	√			
Pacific ocean perch - Pacific Coast	√			
Widow rockfish - Pacific Coast	√			
Yelloweye rockfish - Pacific Coast	√			
Percentage of Stocks in Category	100%			

The Alaska (AK) region has 3 stocks included in this analysis, all of which overfishing is controlled. Of those 3 stocks, 2 (67%) are rebuilding biomass, while the third is not (33%).

Alaska Region				
Stock	**F Controlled/ Biomass Increasing**	**F Controlled/ Biomass Not Increasing**	**F Not Controlled/ Biomass Increasing**	**F Not Controlled/ Biomass Not Increasing**
Blue king crab – Pribilof Islands		√		
Blue king crab – Saint Matthews Island	√			
Snow crab – Bering Sea	√			
Percentage of Stocks in Category	67%	33%		

The Highly Migratory Species Division has 5 stocks that were evaluated. Of these 5 stocks, 3 (60%) have successfully controlled F; only 1 of these 3 stocks, swordfish – North Atlantic, has increasing biomass, as one would expect with lower fishing mortality. The 2 HMS stocks subject to overfishing are responding in different ways: bluefin tuna – West Atlantic has decreasing biomass, which is expected, and albacore – North Atlantic shows increasing biomass.

Highly Migratory Species Division				
Stock	**F Controlled/ Biomass Increasing**	**F Controlled/ Biomass Not Increasing**	**F Not Controlled/ Biomass Increasing**	**F Not Controlled/ Biomass Not Increasing**
Swordfish – North Atlantic	√			
Bigeye tuna - Atlantic		√		
Albacore - North Atlantic			√	
Sandbar shark - Atlantic		√		
Bluefin tuna – Western Atlantic				√
Percentage of Stocks in Category	20%	40%	20%	20%

Table 1. Stocks that have been declared overfished and their status of inclusion or rationale for exclusion in the analysis. The following stocks may be in rebuilding plans but not included in the analysis for the following reasons:

1) The stock has been recently declared overfished, so a rebuilding plan has not yet been implemented;
2) The stock has insufficient data to develop a rebuilding plan;
3) A formal rebuilding program was not submitted[2] under the MSA; and
4) A rebuilding plan is not required.
5) In a rebuilding plan, but the plan has only recently been adopted and the most recent scientific assessment does not yet reflect its measures; and
6) In a rebuilding plan, but the stock does not have reliable estimates of biomass and/or fishing mortality.

Stock	Jurisdiction	Rebuilding Program Progress used in Analysis	Status in Analysis
NORTHEAST REGION			
Atlantic cod - Gulf of Maine *	NEFMC	4/10-year plan	Included
Atlantic cod - Georges Bank *	NEFMC	4/22-year plan	Included
Haddock – Gulf of Maine*	NEFMC	4/10-year plan	Included
Haddock - Georges Bank*	NEFMC	4/10-year plan	Included
American plaice -Gulf of Maine / Georges Bank *	NEFMC	4/10-year plan	Included
Acadian redfish -Gulf of Maine / Georges Bank *	NEFMC	4/47-year plan	Included
Yellowtail Flounder - Georges Bank	NEFMC	2/8-year plan	Excluded - 5
Yellowtail flounder - Southern New England / Mid-Atlantic *	NEFMC	4/10-year plan	Included
Yellowtail flounder -Cape Cod / Gulf of Maine *[3]	NEFMC	4/19-year plan	Included
White hake - Gulf of Maine / Georges Bank *	NEFMC	4/10-year plan	Included
Pollock - Gulf of Maine / Georges Bank *	NEFMC	4/10-year plan	Included
Windowpane - Southern New England / Mid-Atlantic *	NEFMC	4/10-year plan	Included
Winter flounder - Southern New England / Mid-Atlantic *	NEFMC	4/10-year plan	Included
Ocean pout - Northwestern Atlantic Coast *	NEFMC	4/10-year plan	Included
Atlantic halibut - Northwestern Atlantic Coast	NEFMC	N/A	Excluded - 2
Winter skate - Georges Bank / Southern New England	NEFMC	N/A	Excluded - 1
Smooth skate - Gulf of Maine	NEFMC	N/A	Excluded - 1
Barndoor skate - Georges Bank / Southern New England	NEFMC	Year 6 of plan	Included
Thorny skate - Gulf of Maine	NEFMC	Year 6 of plan	Included
Monkfish - Gulf of Maine / Northern Georges Bank	NEFMC / MAFMC	Rebuilt	Included
Monkfish - Southern Georges Bank / Mid-Atlantic	NEFMC / MAFMC	Rebuilt	Included
Spiny dogfish - Atlantic Coast	NEFMC / MAFMC	8/5-year plan	Included
Summer flounder - Mid-Atlantic Coast	MAFMC	9/13-year plan	Included
Scup - Atlantic Coast	MAFMC	1/7-year plan	Excluded – 5
Black sea bass - Mid-Atlantic Coast	MAFMC	8/10-year plan	Excluded - 6
Bluefish - Atlantic Coast	MAFMC	Rebuilt	Included
Butterfish - Gulf of Maine / Cape Hatteras	MAFMC	N/A	Excluded -1

[2] Applicable to Atlantic salmon only - a Final Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon has been developed under the ESA.
[3] SNE – Southern New England; MA – Mid-Atlantic; CC – Cape Cod; GOM – Gulf of Maine

Stock	Jurisdiction	Rebuilding Program Progress used in Analysis	Status in Analysis
Tilefish - Mid-Atlantic Coast	MAFMC	7/10-year plan	Included
Atlantic salmon - Gulf of Maine	NEFMC	N/A	Excluded – 3
** This stock is part of the Northeast Multispecies FMP and has been in a rebuilding plan since 1986.*			
SOUTHEAST REGION			
Snowy grouper - Southern Atlantic Coast	SAFMC	3/34-year plan	Excluded - 5
Black sea bass - Southern Atlantic Coast	SAFMC	3/10-year plan	Excluded - 5
Red porgy - Southern Atlantic Coast	SAFMC	9/18-year plan	Included
Red snapper - Southern Atlantic Coast	SAFMC	N/A	Excluded - 1
Pink shrimp - Southern Atlantic Coast	SAFMC	N/A	Excluded - 4
King Mackerel - Gulf of Mexico	SAFMC / GMFMC	Rebuilt	Included
Gray Triggerfish – Gulf of Mexico	GMFMC	1/6-year plan	Excluded - 5
Red snapper - Gulf of Mexico	GMFMC	7/31-year plan	Excluded - 6
Greater amberjack - Gulf of Mexico	GMFMC	5/10-year plan	Included
Caribbean Grouper Unit 1	CFMC	3/25-year plan	Excluded - 6
Caribbean Grouper Unit 2	CFMC	3/30-year plan	Excluded - 6
Caribbean Grouper Unit 4	CFMC	3/10-year plan	Excluded - 6
Queen conch - Caribbean	CFMC	3/30-year plan	Excluded - 6
NORTHWEST REGION			
Pacific ocean perch - Pacific Coast	PFMC	8/18-year rebuilding plan	Included
Bocaccio - Southern Pacific Coast	PFMC	8/27-year rebuilding plan	Included
Canary rockfish - Pacific Coast	PFMC	7/63-year rebuilding plan	Included
Darkblotched rockfish - Pacific Coast	PFMC	6/10-year rebuilding plan	Included
Cowcod - Southern California	PFMC	7/39-year rebuilding plan	Included
Yelloweye rockfish - Pacific Coast	PFMC	5/82-year rebuilding plan	Included
Widow rockfish - Pacific Coast	PFMC	6/14-year rebuilding plan	Included
Chinook salmon - Northern California Coast: Klamath (fall)	PFMC	N/A	Excluded – 1
Hancock Seamount Groundfish Complex	WPFMC	in progress	Excluded - 6
ALASKA REGION			
Blue King Crab - Pribilof Islands	NPFMC	5/10-year plan	Included
Blue King Crab - Saint Matthews Island	NPFMC	9/10-year plan	Included
Snow Crab - Bering Sea	NPFMC	9/10-year plan	Included
HIGHLY MIGRATORY SPECIES			
Blue marlin - North Atlantic	HMS	Year 10 of Plan	Excluded - 6
White marlin - North Atlantic	HMS	Year 10 of Plan	Excluded - 6
Sailfish – Western Atlantic	HMS	Year 10 of Plan	Excluded - 6
Bigeye Tuna - Atlantic	HMS	Year 10 of Plan	Included
Albacore - North Atlantic	HMS	Year 2 of Plan	Included
Bluefin Tuna – Western Atlantic	HMS	10/19-year plan	Included
Swordfish - North Atlantic	HMS	8/10-year plan	Included
Sandbar shark - Atlantic	HMS	1/66-year plan**	Included
Porbeagle - Atlantic	HMS	N/A	Excluded - 5
Dusky shark - Atlantic	HMS	N/A	Excluded - 5

Stock	Jurisdiction	Rebuilding Program Progress used in Analysis	Status in Analysis
Blacknose Shark – Atlantic	HMS	N/A	Excluded – 1
** *The rebuilding plan for this stock was first implemented in 2004, but was later revised in 2008*			

Table 2. Quad chart containing all overfished stocks evaluated in this document. The green and red colors highlight stock that have biomass (B) responding as expected to fishing mortality (F). The yellow color indicates the stocks are not responding to F status as expected.

	F is controlled	F/F_{MSY} >1 (Overfishing)
B/B_{MSY} Increasing	Summer flounder - Mid-Atlantic Coast Barndoor skate - Georges Bank / Southern New England Bluefish - Atlantic Coast Bocaccio - Southern Pacific Coast Canary rockfish - Pacific Coast Cowcod - Southern California Darkblotched rockfish - Pacific Coast Tilefish - Mid-Atlantic Coast Haddock – Georges Bank* Haddock – Gulf of Maine* Monkfish - Gulf of Maine / Northern Georges Bank Monkfish - Southern Georges Bank / Mid-Atlantic King mackerel - Gulf of Mexico Pacific ocean perch - Pacific Coast Pollock - Gulf of Maine / Georges Bank* Red porgy - Southern Atlantic Coast Acadian redfish - Gulf of Maine / Georges Bank* Spiny dogfish - Atlantic Coast Swordfish – North Atlantic Widow rockfish - Pacific Coast Yelloweye rockfish - Pacific Coast Blue king crab – Saint Matthews Island Snow crab – Bering Sea	Albacore - North Atlantic Greater amberjack - Gulf of Mexico
B/B_{MSY} Not increasing	American plaice - Gulf of Maine / Georges Bank* Bigeye tuna - Atlantic Ocean pout - Northwestern Atlantic Coast* Sandbar shark - Atlantic Windowpane - Southern New England / Mid-Atlantic* Blue king crab – Pribilof Islands	Bluefin tuna – West Atlantic Atlantic cod - Georges Bank* Atlantic cod - Gulf of Maine* White hake - Gulf of Maine / Georges Bank* Winter flounder - Southern New England / Mid-Atlantic* Yellowtail flounder - Southern New England / Mid-Atlantic* Yellowtail flounder - Cape Cod / Gulf of Maine* Thorny skate - Gulf of Maine

* This stock is part of the Northeast Multispecies FMP and has been in a rebuilding plan since 1986.