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. 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.

Rebuilding of a stock will generally occur if more fish survive to maturity than are lost to mortality. There are several types of mortality including natural and fishing mortality. Natural mortality, such as predation, occurs regardless of management control. Fishing mortality (F) can be directly controlled through the management measures of Regional Fisheries Management Councils (RFMC). 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 fish can survive and spawn, thus increasing the probability of a stock rebuilding. NMFS conducts stock assessments to estimate 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 incorporate these values, in addition to many other factors, to predict the time it will take for the stock to rebuild. Generally, when 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 and there are several reasons for this. 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, including 4 of the 6 stocks rebuilt in the last year (Table 1), to determine if they were candidates for inclusion in a trends analysis. This analysis includes stocks that are currently rebuilding from an overfished condition or have rebuilt in 2011. 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, the initial estimates of F and B in the year when the stock was first declared overfished are usually not the same as the current estimates of F and B for that year. Estimates of F and B for prior years are often revised in

subsequent stock assessments. These revisions can be the result of changes to the type of stock assessment conducted (i.e. index vs. size/age/stage-structured model), uncertainty inherent in stock assessments, or a variety of other reasons.

There are several reasons why some of the 65 stocks were not appropriate for the NMFS analysis. Eight of these 65 stocks were not included in the analysis because they are not in rebuilding plans for one of the following reasons: 1) the stock has been recently declared overfished, so a rebuilding plan has not yet been implemented; 2) A formal rebuilding program was not submitted under the MSA[1]; or 3) A rebuilding plan is not required. An additional 20 stocks are in rebuilding plans, and were not included in the analysis for one of the following reasons: 4) the rebuilding plan has only recently been adopted and the most recent scientific assessment does not include a full year under the plan; 5) the stock does not have a reliable time series of biomass and/or fishing mortality estimates; 6) the stock is in a rebuilding plan, but stock has not been assessed recently to determine effectiveness of measures; and 7) salmon rebuilding targets levels (based on escapement) are not comparable to marine stocks that rebuild to a target biomass. The remaining 37stocks were considered appropriate for the analysis and their F status and B trends are shown in Table 2. Four of the stocks in this year's analysis were declared rebuilt in 2011; two rebuilt stocks were not included in the analysis because they are salmon stocks and rebuilding is not comparable to marine stocks that rebuild to a target biomass.

Results and Discussion

Using data from the most recent stock assessment, figures were created to illustrate the trends in F and B for the 37 stocks. For most stocks, this time series extends four years prior to the overfished declaration. To evaluate the fishing mortality trend, F is considered controlled if it is below the overfishing level ($F/F_{MSY} <1$) in the terminal year. If F is controlled, one would expect B to increase if conditions are favorable, but that is not always the case. To evaluate the biomass trend, the last few years (not just the terminal year) of biomass estimates are compared to the sustainable level (B/B_{MSY}). If the last few years show an increase, then biomass is increasing. If the last few years show a decrease or biomass levels are essentially unchanged, then biomass is not increasing.

Of the 37 rebuilding stocks that were evaluated for fishing mortality trends, 25 stocks (68%) had F controlled by the end of the time series (Table 2). For these 25 stocks, 17 stocks (68%) show increases in biomass and 8 stocks (32%) show declines or flat trends in biomass. For the 12 stocks where F has not been adequately controlled, 7 (58%) 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 18 stocks in rebuilding plans that were evaluated. Of these, 13 (72%) have successfully controlled F during the available time series. Of those 13 stocks, 8[2, 3] (62%) are rebuilding biomass; 2 of these 13 stocks have now fully rebuilt (haddock –Gulf of Maine and summer flounder). Of the 5 NE stocks where overfishing is not controlled, 4 out of 5 (80%) do not have an increase in biomass.

Northeast Region				
Stock	**F Controlled/ Biomass Increasing**	**F Controlled/ Biomass Not Increasing**	**F Not Controlled/ Biomass Increasing**	**F Not Controlled/ Biomass Not Increasing**
Acadian redfish - Gulf of Maine / Georges Bank	√			
American plaice - Gulf of Maine / Georges Bank	√			
Atlantic cod - Georges Bank				√
Atlantic cod - Gulf of Maine			√	
Atlantic halibut – Northwestern Atlantic Coast		√		
Barndoor skate - Georges Bank / Southern New England	√			
Haddock – Gulf of Maine[2]		√		
Ocean pout - Northwestern Atlantic Coast		√		
Summer flounder - Mid-Atlantic Coast	√			
Thorny skate - Gulf of Maine		√		
Tilefish - Mid-Atlantic Coast	√			
White hake - Gulf of Maine / Georges Bank				√
Windowpane - Southern New England / Mid-Atlantic		√		
Winter flounder – Georges Bank	√			
Winter flounder - Southern New England / Mid-Atlantic	√			
Yellowtail flounder - Cape Cod / Gulf of Maine				√
Yellowtail flounder - Georges Bank	√			
Yellowtail flounder - Southern New England / Mid-Atlantic				√
Percentage of Stocks in Category	44%	28%	6%	22%

[2] The biomass is decreasing from a previously sustainable level. Due to a new type of stock assessment that was used (index model replaced by a size/age/stage-structured model), a different estimate of past stock status was produced.

The Southeast (SE) region has 4 stocks included in this analysis. Of those four, overfishing is controlled in 1 stock. Red porgy – Southern Atlantic Coast, where overfishing ended in 2000, is rebuilding biomass. However, despite ongoing overfishing, black sea bass – Southern Atlantic coast and red snapper – Gulf of Mexico continued to build biomass.

Southeast Region				
Stock	**F Controlled/ Biomass Increasing**	**F Controlled/ Biomass Not Increasing**	**F Not Controlled/ Biomass Increasing**	**F Not Controlled/ Biomass Not Increasing**
Black sea bass – Southern Atlantic Coast			√	
Greater amberjack – Gulf of Mexico				√
Red porgy - Southern Atlantic Coast	√			
Red snapper – Gulf of Mexico			√	
Percentage of Stocks in Category	25%		50%	25%

The seven Northwest (NW) region stocks in this analysis have both controlled overfishing and 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 is estimated to rebuild biomass over a 68-year period. Despite the slight apparent increase in biomass in the figure, the cowcod has increased B/B_{MSY} from 0.058 at the overfished declaration to 0.112 at the end of the time series, an increase of 93%.

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 2 stocks included in this analysis, both of which overfishing is controlled. One stock is rebuilding biomass, while the other stock is not.

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		√		
Snow crab – Bering Sea	√			
Percentage of Stocks in Category	50%	50%		

The Highly Migratory Species Division has 6 stocks that were evaluated. Of these 6 stocks, 2 (33%) have successfully controlled F; none of these two stocks have increasing biomass. The 4 HMS stocks subject to overfishing are responding in different ways; blue marlin and dusky shark have decreasing biomass, which is expected, and albacore and bluefin tuna show 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**
Albacore - North Atlantic			√	
Bigeye tuna - Atlantic		√		
Bluefin Tuna – Western Atlantic			√	
Blue Marlin – Atlantic				√
Sandbar Shark - Atlantic		√		
Dusky Shark - Atlantic				√
Percentage of Stocks in Category		33%	33%	33%

Table 1. Stocks that have been declared overfished and their status of inclusion or rationale for exclusion in the analysis. Some 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) A formal rebuilding program was not submitted under the MSA[3].
3) A rebuilding plan is not required.
4) In a rebuilding plan, but the plan has only recently been adopted and the most recent scientific assessment does not yet include a full year under the plan.
5) In a rebuilding plan, but the stock does not have reliable estimates of biomass and/or fishing mortality.
6) In a rebuilding plan, but stock has not been assessed recently to determine effectiveness of measures.
7) Salmon rebuilding targets levels (based on escapement) are not comparable to marine stocks that rebuild to a target biomass.

Stock	Jurisdiction	Current Rebuilding Program Progress	Status in Analysis
NORTHEAST REGION			
Acadian redfish - Gulf of Maine / Georges Bank*	NEFMC	8/47-year plan	Included
American plaice - Gulf of Maine / Georges Bank*	NEFMC	8/10-year plan	Included
Atlantic cod - Georges Bank*	NEFMC	8/22-year plan	Included
Atlantic cod - Gulf of Maine*	NEFMC	8/10-year plan	Included
Atlantic halibut - Northwestern Atlantic Coast	NEFMC	8/52-year plan	Included
Atlantic salmon - Gulf of Maine	NEFMC	Not included	Excluded – 2
Atlantic wolffish - Gulf of Maine / Georges Bank	NEFMC	Not included	Excluded - 4
Barndoor skate - Georges Bank / Southern New England	NEFMC	Year 9 of plan	Included
Butterfish (Atlantic)	MAFMC	Not included	Excluded -4
Haddock - Gulf of Maine*	NEFMC	Rebuilt	Included
Ocean pout - Northwestern Atlantic Coast*	NEFMC	8/10-year plan	Included
Smooth skate - Gulf of Maine	NEFMC	Not included	Excluded - 4
Summer flounder - Mid-Atlantic Coast	MAFMC	Rebuilt	Included
Thorny skate - Gulf of Maine	NEFMC	Year 9 of 25-year plan	Included
Tilefish - Mid-Atlantic Coast	MAFMC	11/10-year plan	Included
White hake - Gulf of Maine / Georges Bank*	NEFMC	8/10-year plan	Included
Windowpane - Gulf of Maine / Georges Bank	NEFMC	Not included	Excluded - 4
Windowpane - Southern New England / Mid-Atlantic*	NEFMC	8/10-year plan	Included
Winter flounder - Georges Bank	NEFMC	2/7-year plan	Included
Winter flounder - Southern New England / Mid-Atlantic*	NEFMC	8/10-year plan	Included
Witch flounder - Northwestern Atlantic Coast	NEFMC	Not included	Excluded - 4
Yellowtail flounder - Cape Cod / Gulf of Maine*	NEFMC	8/19-year plan	Included
Yellowtail flounder - Georges Bank	NEFMC	6/10-year plan	Included
Yellowtail flounder - Southern New England / Mid-Atlantic*	NEFMC	8/10-year plan	Included
** This stock is contained in the Northeast Multispecies FMP and has been in a rebuilding plan since 1986.*			

[3] 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.

Stock	Jurisdiction	Current Rebuilding Program Progress	Status in Analysis
SOUTHEAST REGION			
Caribbean Grouper Unit 1	CFMC	Not included	Excluded - 5
Black sea bass - Southern Atlantic Coast	SAFMC	7/10-year plan	Included
Caribbean Grouper Unit 2	CFMC	Not included	Excluded - 5
Caribbean Grouper Unit 4	CFMC	Not included	Excluded - 5
Gag - Gulf of Mexico	GMFMC	Not included	Excluded – 1
Gray triggerfish – Gulf of Mexico	GMFMC	Not included	Excluded - 4
Greater amberjack – Gulf of Mexico	GMFMC	9/10-year plan	Included
Pink shrimp - Southern Atlantic Coast	SAFMC	Not included	Excluded - 3
Queen conch – Caribbean	CFMC	Not included	Excluded - 5
Red grouper - Southern Atlantic Coast	SAFMC	Not included	Excluded - 1
Red porgy - Southern Atlantic Coast	SAFMC	12/18-year plan	Included
Red snapper – South Atlantic	SAFMC	Not included	Excluded - 1
Red snapper - Gulf of Mexico	GMFMC	11/32-year plan	Included
Snowy grouper - Southern Atlantic Coast	SAFMC	Not included	Excluded - 6
NORTHWEST REGION			
Bocaccio - Southern Pacific Coast	PFMC	12/22-year rebuilding plan	Included
Canary rockfish - Pacific Coast	PFMC	11/26-year rebuilding plan	Included
Chinook salmon - Northern California Coast: Klamath (fall)	PFMC	Rebuilt	Excluded - 7
Chinook salmon - California Central Valley: Sacramento (fall)	PFMC	Not included	Excluded - 7
Coho salmon - Washington Coast: Queets	PFMC	Not included	Excluded - 7
Coho salmon - Washington Coast: Western Strait of Juan de Fuca	PFMC	Rebuilt	Excluded - 7
Cowcod - Southern California	PFMC	11/67-year rebuilding plan	Included
Darkblotched rockfish - Pacific Coast	PFMC	10/23-year rebuilding plan	Included
Pacific ocean perch - Pacific Coast	PFMC	12/20-year rebuilding plan	Included
Petrale sole - Pacific Coast	PFMC	1/4-year rebuilding plan	Excluded – 1
Widow rockfish - Pacific Coast	PFMC	Rebuilt	Included
Yelloweye rockfish - Pacific Coast	PFMC	9/71-year rebuilding plan	Included
PACIFIC ISLANDS REGION			
Seamount Groundfish Complex - Hancock Seamount	WPFMC	Not included	Excluded - 5
ALASKA REGION			
Blue King Crab - Pribilof Islands	NPFMC	8/10-year plan	Included
Snow Crab - Bering Sea	NPFMC	Rebuilt	Included
Southern Tanner crab - Bering Sea	NPFMC	Not included	Excluded - 1
HIGHLY MIGRATORY SPECIES			
Blue marlin – North Atlantic	HMS	Year 11 of plan	Included
Albacore - North Atlantic	HMS	Year 6 of Plan	Included
Bigeye tuna – Atlantic	HMS	Year 13 of Plan	Included

Stock	Jurisdiction	Current Rebuilding Program Progress	Status in Analysis
Blacknose shark – Atlantic	HMS	Not included	Excluded – 4
Bluefin tuna – Western Atlantic	HMS	13/19-year plan	Included
Dusky shark – Atlantic	HMS	Year 4/100-year plan	Included
Porbeagle shark – Atlantic	HMS	Not included	Excluded - 4
Sailfish – Western Atlantic	HMS	Not included	Excluded - 5
Sandbar shark – Atlantic	HMS	4/66-year plan	Included
Scalloped hammerhead – Atlantic	HMS	Not included	Excluded - 1
White marlin – North Atlantic	HMS	Not included	Excluded - 5

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

	Fishing Mortality is Controlled	Fishing Mortality is Not Controlled (Overfishing)
Biomass Increasing	• Acadian redfish - Gulf of Maine / Georges Bank* • American plaice - Gulf of Maine / Georges Bank* • Barndoor skate - Georges Bank/Southern New England • Yellowtail Flounder - Georges Bank • Summer flounder - Mid-Atlantic Coast • Tilefish - Mid-Atlantic Coast • Red porgy - Southern Atlantic Coast • 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 • Snow crab – Bering Sea** • Winter flounder - Georges Bank • Winter flounder - Southern New England / Mid-Atlantic*	• Atlantic cod – Gulf of Maine* • Red snapper – Gulf of Mexico • Albacore - North Atlantic • Black sea bass – Southern Atlantic Coast • Bluefin tuna – Western Atlantic
Biomass Not increasing	• Atlantic halibut – Northwestern Atlantic Coast • Haddock – Gulf of Maine* • Ocean pout - Northwestern Atlantic Coast* • Windowpane - Southern New England/Mid-Atlantic* • Bigeye tuna - Atlantic • Sandbar Shark - Atlantic • Blue king crab – Pribilof Islands** • Thorny skate - Gulf of Maine	• Greater amberjack – Gulf of Mexico • Atlantic cod – Georges Bank* • White hake - Gulf of Maine / Georges Bank* • Yellowtail flounder - Cape Cod/Gulf of Maine* • Yellowtail flounder - Southern New England / Mid-Atlantic* • Blue marlin – Atlantic • Dusky Shark - Atlantic

* This stock is part of the Northeast Multispecies FMP and has been in a rebuilding plan since 1986.
**Although this stock is not subject to overfishing, there is no time series, or multiple year estimates, of fishing mortality