

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 within 10 years. 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 than are lost to mortality. 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 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 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 and Results

Trends in B and F can demonstrate a rebuilding plan's progress in achieving targets for overfished stocks. NMFS reviewed 59 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. 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 overfished declaration are in this analysis.

There are several reasons why some of the (59) stocks were not appropriate for the NMFS analysis. Stocks that were not good candidates for this analysis include: 1) the stock has been recently declared overfished, so a rebuilding plan has not yet been implemented; 2) the rebuilding plan has only recently been adopted and the most recent scientific assessment does not yet reflect its measures; 3) the stock will have its rebuilding plan revised in 2008 because current rebuilding plans have not been successful; 4) the stock has

insufficient data to develop a rebuilding plan; 5) the stock does not have reliable estimates of biomass and/or fishing mortality; and 6) stocks whose assessment reports do not reflect the current state of knowledge because biomass and fishing mortality reference points are in the process of being revised. Of the 55 stocks in rebuilding plans, 34 stocks were considered appropriate for the analysis and their F status and B trends are shown in [Table 2](#).

Discussion

Using data from the most recent stock assessment, figures were created to illustrate the trends in F and B for the 34 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 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 stagnating. These stocks, such as [windowpane flounder](#), are included in the B is not increasing category.

Of the 34 rebuilding stocks that were evaluated, 24 stocks (71%) had F controlled by the end of the time series ([Table 2](#)). For these 24 stocks, 18 stocks (75%) show increases in biomass and 6 stocks (25%) show declines or flat trends in biomass. For the remaining 10 stocks where F has not been adequately controlled, 7 (70%) show declines or flat trends in biomass. These results demonstrate the importance in controlling F in order to achieve rebuilding.

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 is estimated to rebuild biomass over a 38 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	√			
canary rockfish	√			
cowcod	√			
darkblotched rockfish	√			
Pacific ocean perch	√			
widow rockfish	√			
yelloweye rockfish	√			
Percentage of Stocks in Category	100%			

The Northeast (NE) region had 19 stocks in rebuilding plans that were evaluated. Of these, 12 (63%) have successfully controlled F during the available time series. Of those 12 stocks, 8 (67%) are rebuilding biomass. Of the 7 overfished NE stocks where overfishing was occurring, 6 (86%) have declining biomass. Overfishing of [summer flounder](#) occurred throughout this time series yet biomass increased from the

overfishing declaration until 2006.

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		√		
barndoor skate	√			
bluefish (except Gulf of Mexico)	√			
cod – Georges Bank				√
cod – Gulf of Maine				√
golden tilefish	√			
haddock – Georges Bank	√			
haddock – Gulf of Maine	√			
ocean pout		√		
pollock	√			
redfish	√			
spiny dogfish	√			
summer flounder			√	
thorny skate		√		
white hake				√
windowpane flounder – SNE/MA		√		
winter flounder – SNE/MA				√
yellowtail flounder – CC/GoM				√
yellowtail flounder – SNE/MA				√
Percentage of Stocks in Category	42%	21%	5%	32%

The South Atlantic (SA) region has controlled overfishing in 2 out of the 3 stocks in this evaluation. As expected, king mackerel gulf group and red porgy, where overfishing has ended, are rebuilding biomass. However, despite ongoing overfishing, [greater amberjack Gulf of Mexico](#) continued to build biomass every year after the overfished declaration, 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 group	√			
red porgy	√			
Percentage of Stocks in Category	67%		33%	

The Highly Migratory Species management program has 5 stocks that were evaluated. Of these 5 stock, 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 where overfishing is occurring are responding in different ways: [Bluefin tuna](#) with decreasing biomass as one would expect and

[albacore](#) – North Atlantic with increased 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		√		
bluefin tuna – West Atlantic				√
Percentage of Stocks in Category	20%	40%	20%	20%

Table 1. Northeast region stocks that have been declared overfished and have rebuilding plans. The rationale for exclusion from the analysis is provided. *These stocks are part of the Northeast Multispecies FMP and have been in a rebuilding plan since 1986.

Stock	Jurisdiction	Rebuilding Program Progress	Status of Analysis
Northeast Region			
Cod - Gulf of Maine*	NEFMC	4/10-year plan	Included in Analysis
Cod - Georges Bank*	NEFMC	4/22-year plan	Included in Analysis
Haddock - Gulf of Maine*	NEFMC	4/10-year plan	Included in Analysis
Haddock - Georges Bank*	NEFMC	4/10-year plan	Included in Analysis
American Plaice*	NEFMC	4/10-year plan	Included in Analysis
Redfish*	NEFMC	4/47-year plan	Included in Analysis
Yellowtail Flounder - Georges Bank	NEFMC	2/8-year plan	2) The rebuilding plan has only recently been adopted and the most recent scientific assessment does not yet reflect its measures
Yellowtail Flounder - Southern New England/Middle Atlantic*	NEFMC	4/10-year plan	Included in Analysis
Yellowtail Flounder - Cape Cod / Gulf of Maine*	NEFMC	4/19-year plan	Included in Analysis
White Hake*	NEFMC	4/10-year plan	Included in Analysis
Pollock*	NEFMC	4/10-year plan	Included in Analysis
Windowpane Flounder - Southern New England /Middle Atlantic*	NEFMC	4/10-year plan	Included in Analysis
Winter Flounder - Southern New England / Middle Atlantic*	NEFMC	4/10-year plan	Included in Analysis
Ocean Pout*	NEFMC	4/10-year plan	Included in Analysis
Atlantic Halibut	NEFMC	N/A	4) the stock has insufficient data to develop a rebuilding plan
Winter Skate	NEFMC	N/A	1) the stock has been recently declared overfished, so a rebuilding plan has not yet been implemented
Barndoor Skate	NEFMC	year 5 of plan	Included in Analysis
Thorny Skate	NEFMC	year 5 of plan	Included in Analysis
			6) stocks whose assessment reports do not reflect the current state of knowledge because biomass and fishing mortality

Monkfish - North	NEFMC / MAFMC	8/10-year plan	reference points are in the process of being revised. NOTE: When these new reference points are adopted in 2008, the stocks will be declared rebuilt
Monkfish - South	NEFMC / MAFMC	8/10-year plan	6) stocks whose assessment reports do not reflect the current state of knowledge because biomass and fishing mortality reference points are in the process of being revised. NOTE: When these new reference points are adopted in 2008, the stocks will be declared rebuilt
Spiny Dogfish	NEFMC / MAFMC	8/5-year plan	Included in Analysis
Summer Flounder	MAFMC	8/13-year plan	Included in Analysis
Scup	MAFMC	N/A	2) The rebuilding plan has only recently been adopted and the most recent scientific assessment does not yet reflect its measures. NOTE: The rebuilding plan will be implemented on 1/1/08.
Black Sea Bass	MAFMC	8/10-year plan	5) the stock does not have reliable estimates of biomass and/or fishing mortality
Bluefish (except Gulf of Mexico)	MAFMC	7/9-year plan	Included in Analysis
Butterfish (Atlantic)	MAFMC	N/A	1) the stock has been recently declared overfished, so a rebuilding plan has not yet been implemented. NOTE: The rebuilding plan is expected to be implemented by 1/1/09
Golden Tilefish (except South Atlantic and Gulf of Mexico)	MAFMC	7/10-year plan	Included in Analysis

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Table 1 continued. South Atlantic, Northwest, and Pacific Island region stocks that have been declared overfished and have rebuilding plans. The rationale for exclusion from the analysis is provided.

South Atlantic Region

Snowy Grouper	SAFMC	15/15-year plan	3) the stock will have its rebuilding plan revised in 2008 because current rebuilding plans have not been successful
Black Sea Bass	SAFMC	7/10-year plan	3) the stock will have its rebuilding plan revised in 2008 because current rebuilding plans have not been successful
Red Porgy	SAFMC	9/18-year plan	Included in Analysis
King Mackerel - Gulf Group	SAFMC / GMFMC	year 20 of plan	Included in Analysis
Red Snapper	GMFMC	7/31-year plan	5) the stock does not have reliable estimates of biomass and/or fishing mortality
Greater Amberjack	GMFMC	5/10-year plan	Included in Analysis
Grouper Unit 1	CFMC	3/25-year plan	5) the stock does not have reliable estimates of biomass and/or fishing mortality
Grouper Unit 2	CFMC	3/30-year plan	5) the stock does not have reliable estimates of biomass and/or fishing mortality
Grouper Unit 4	CFMC	3/10-year plan	5) the stock does not have reliable estimates of biomass and/or fishing mortality
Queen Conch	CFMC	3/30-year plan	5) the stock does not have reliable estimates of biomass and/or fishing mortality

Northwest Region

Pacific Ocean Perch	PFMC	8/18-year rebuilding plan	Included in Analysis
Bocaccio	PFMC	8/27-year rebuilding plan	Included in Analysis
Canary Rockfish	PFMC	7/63-year rebuilding plan	Included in Analysis
Darkblotched Rockfish	PFMC	6/10-year rebuilding plan	Included in Analysis
Cowcod	PFMC	7/39-year rebuilding plan	Included in Analysis
Yelloweye Rockfish	PFMC	5/82-year rebuilding plan	Included in Analysis
Widow Rockfish	PFMC	6/14-year rebuilding plan	Included in Analysis

Pacific Islands Region

Seamount Groundfish Complex - Hancock Seamount	WPFMC	in progress	5) the stock does not have reliable estimates of biomass and/or fishing mortality
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Table 1 continued. Alaska region and Highly Migratory stocks that have been declared overfished and have rebuilding plans. The rationale for exclusion from the analysis is provided.

Alaska Region			
Blue King Crab - Pribilof Islands	NPFMC	4/10-year plan	6) stocks whose assessment reports do not reflect the current state of knowledge because biomass and fishing mortality reference points are in the process of being revised.
Blue King Crab - Saint Matthews Island	NPFMC	8/10-year plan	6) stocks whose assessment reports do not reflect the current state of knowledge because biomass and fishing mortality reference points are in the process of being revised.
Snow Crab - Bering Sea	NPFMC	8/10-year plan	6) stocks whose assessment reports do not reflect the current state of knowledge because biomass and fishing mortality reference points are in the process of being revised.
Highly Migratory Species			
Blue Marlin - Atlantic	HMS	Phase I implemented	5) the stock does not have reliable estimates of biomass and/or fishing mortality
White Marlin - Atlantic	HMS	Phase I implemented	5) the stock does not have reliable estimates of biomass and/or fishing mortality
Sailfish - West Atlantic	HMS	not internationally implemented	5) the stock does not have reliable estimates of biomass and/or fishing mortality
Bigeye Tuna - Atlantic	HMS	not internationally implemented	Included in Analysis
Albacore - North Atlantic	HMS	not internationally implemented	Included in Analysis
Bluefin Tuna - West Atlantic	HMS	10/20-year plan	Included in Analysis
Swordfish - North Atlantic	HMS	8/10-year plan	Included in Analysis
Sandbar Shark	HMS	4/26-year plan	Included in Analysis
Large Coastal Shark Complex	HMS	4/26-year plan	5) the stock does not have reliable estimates of biomass and/or fishing mortality. NOTE: Although this stock complex is currently listed as overfished, it is still managed under a rebuilding plan
Porbeagle Shark	HMS	N/A	1) the stock has been recently declared overfished, so a rebuilding plan has not yet been implemented
Dusky Shark	HMS	N/A	1) the stock has been recently declared overfished, so a rebuilding plan has not yet been implemented

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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 (Slides)	F/F_{MSY} >1 (Overfishing)
B/B_{MSY} increasing	<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> barndoor skate bluefish (except Gulf of Mexico) bocaccio canary rockfish cowcod darkblotched rockfish golden tilefish haddock – Georges Bank* haddock – Gulf of Maine* </div> <div style="width: 45%;"> king mackerel – gulf group Pacific ocean perch pollock* red porgy redfish* Spiny dogfish swordfish – North Atlantic widow rockfish yelloweye rockfish </div> </div>	albacore - North Atlantic greater amberjack - GoM summer flounder Slides
B/B_{MSY} Not increasing	American plaice* bigeye tuna - Atlantic ocean pout* sandbar shark thorny skate windowpane flounder – SNE/MA* Slides	bluefin tuna – West Atlantic cod – Georges Bank* cod – Gulf of Maine* white hake* winter flounder – SNE/MA* yellowtail flounder – SNE/MA* yellowtail flounder – CC/GoM* Slides

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