FISH ECONOMICS

The Benefits of Rebuilding U.S. Ocean Fish Populations

Authors
Ussif Rashid Sumaila, Fisheries Economics Research Unit, Fisheries Centre, University of British Columbia, Vancouver, B.C., r.sumaila@fisheries.ubc.ca

Elizabeth Suatoni, consultant, New Haven, Connecticut, lisa.suatoni@aya.yale.edu

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EXECUTIVE SUMMARY

U.S. fish stocks are a valuable natural resource that provides a wealth of environmental and economic benefits. Fish populations benefit regional economies by supporting the fishing industry, wholesale and retail fish markets, restaurants, recreational fishing, diving, and other activities.

In recent decades, however, what once was considered an almost endless resource has declined precipitously on the Atlantic and Pacific coasts and in the Gulf of Mexico. The nation's foremost fisheries legislation, the Magnuson-Stevens Fishery Conservation and Management Act (MSA), was amended in 1996 by the Sustainable Fisheries Act (SFA) to emphasize the need to end overfishing, rebuild overfished stocks, and establish sustainable management practices. Under the direction of the National Marine Fisheries Service (NMFS), regional fisheries councils are charged with developing rebuilding plans to restore fish populations to levels that can produce maximum sustainable yields in as short a time as possible.

As Congress moves to reauthorize the MSA, it is important to evaluate the economic benefits of rebuilding depleted fish stocks, especially as dozens of fisheries remain overfished. The need for strong protection of fish populations was underscored last year in reports by two national blue-ribbon panels—the independent Pew Oceans Commission and the U.S. Commission on Ocean Policy, the latter appointed by President Bush. Both commissions reached similar conclusions: destructive fishing practices seriously threaten the vitality of our ocean resources. Both panels recommended immediate actions to strengthen ocean protection before it's too late.

This technical paper assesses some of the economic benefits associated with rebuilding a number of valuable federally managed ocean fish populations that have been declared overfished,[1] determining the potential net present value (NPV) that can be derived by the commercial and recreational sectors from rebuilding 17 different overfished stocks from around the United States.[2]

Two management scenarios were analyzed and compared. The "recent catch" scenario approximates what might happen if overfished populations are not rebuilt to healthy levels, and current catch levels were to continue into the future essentially unchanged. The "rebuilding" scenario, on the other hand, uses the projected catches that are expected as the stocks rebuild following implementation of the currently adopted rebuilding plans, as mandated by the MSA.

The analysis was carried out for the rebuilding time period defined in the adopted rebuilding plans for the 17 stocks; these time frames varied between 2 and 22 years. The total estimated net present value (NPV) from all the 17

[1] This paper is a follow up to a preliminary report, which took a snapshot approach. In the preliminary report, we computed commercial and recreational gross fisheries values per annum for overfished U.S. stocks after they have been rebuilt, and compared them to equivalent gross values under a recent catch scenario. The present paper provides a more comprehensive analysis of benefits and costs of rebuilding overfished U.S. stocks over time.
[2] Net present value is the discounted flow of net benefits over the time horizon of a project or policy.

stocks studied under the recent catch scenario is $194 million. The equivalent amount under the rebuilding scenario is $567 million. Hence, in total, the rebuilding scenario delivered approximately three times the recent catch scenario NPV. These gains represent only a fraction of the total potential gains associated with rebuilding depleted fish stocks, as this analysis was conducted on a subset of federally declared overfished fish populations (17 out of 76 in 2003) and because it represents only a partial economic valuation for those 17 stocks.

The results indicate that the potential to increase net economic benefits from currently overfished stocks of the United States is high if the stocks are rebuilt. It is therefore economically sensible to stay the course with respect to restoration of overfished U.S. stocks. Indeed, it appears that much can be gained from strengthening these efforts.

INTRODUCTION

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) as amended in 1996 by the Sustainable Fisheries Act (SFA) emphasizes the need to end overfishing, rebuild overfished stocks, and establish management plans designed to ensure biologically and economically sustainable fisheries.

As seen in the examples of Georges Bank cod and Pacific Ocean perch, catch profiles over recent history show a sharp decline (Figures 1a and b). Recently adopted rebuilding plans aim to restore these two populations over the next 21 and 22 years, respectively, with a resulting increase in catches. The goal is to restore fish populations to levels that can produce maximum sustainable yields.

Figure 1a: Historic catch and adopted rebuilding plan for Georges Bank cod

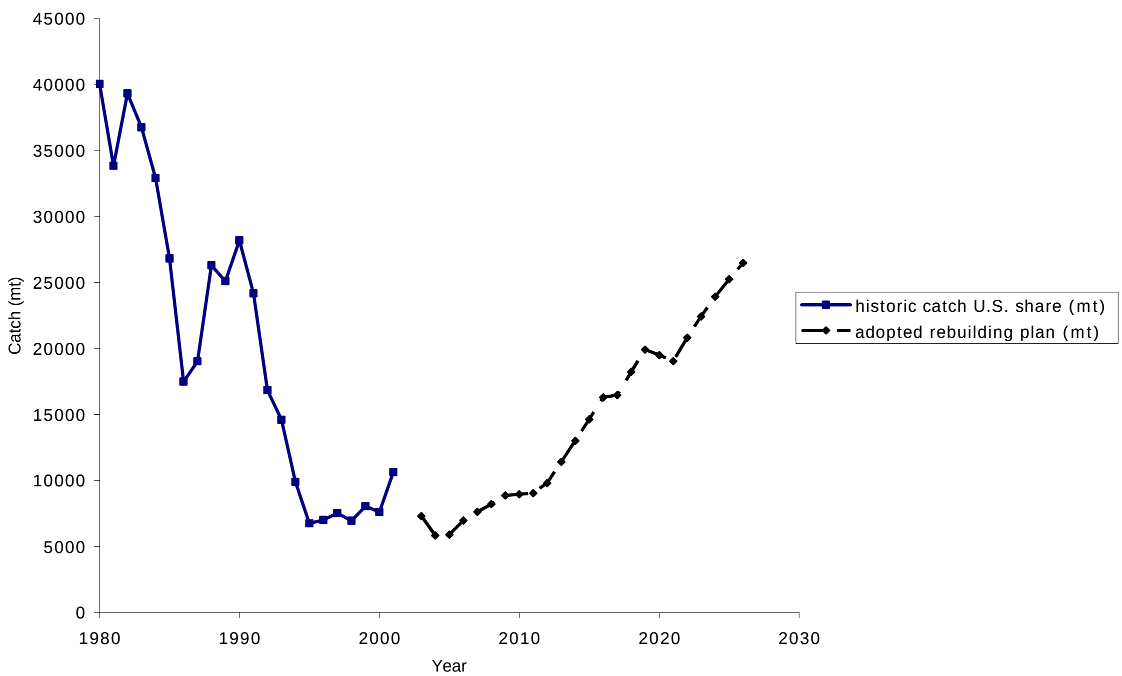
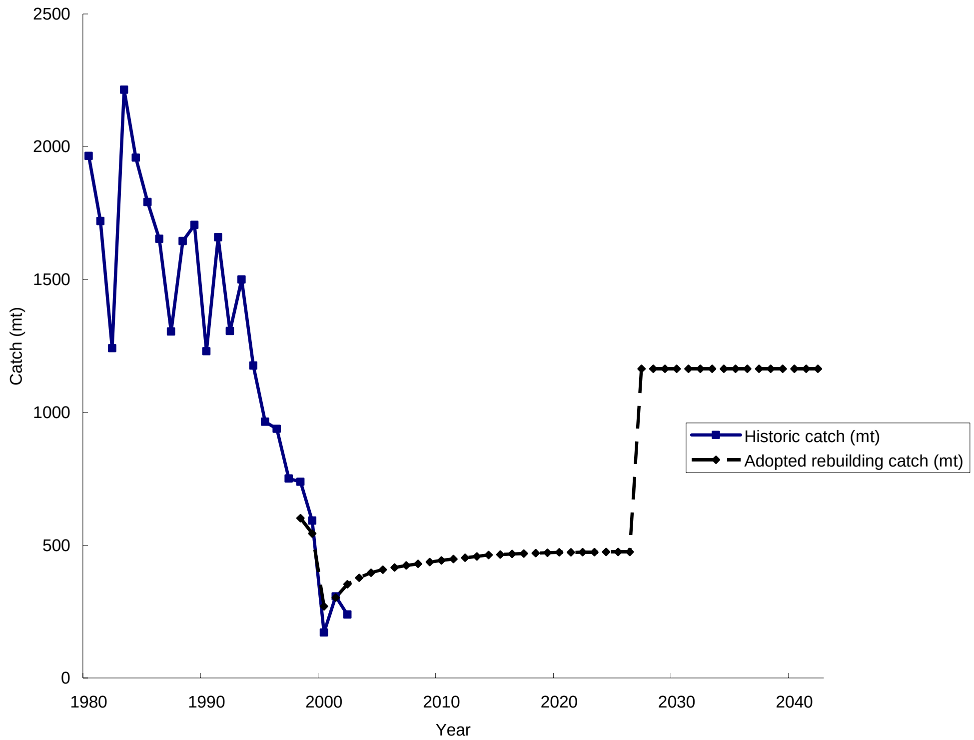


Figure 1b: Historic catch and adopted rebuilding plan for Pacific Ocean perch



Considerable attention has been paid to the scientific issues relating to the status of stocks and the rebuilding of overfished species. There has been less emphasis, however, on assessing the economic issues associated with rebuilding. This study seeks to expand our knowledge of the economics of rebuilding depleted fish stocks.

The main objective of this report is to quantify potential economic benefits to the nation from rebuilding a number of valuable ocean fish populations. For a subset of federally managed overfished stocks, the net present values (NPVs) of recent fishery catches from current, non-rebuilt stocks is compared to expected catches from stocks that are rebuilding according to NMFS-approved rebuilding plans.[3] This study expands on studies that NMFS has conducted by focusing on individual stocks (not just aggregates of stocks) and increasing the number of species for which quantitative economic values are estimated.

It should be noted that a full valuation of the total economic value (Krutilla, 1967, Goulder and Kennedy, 1997, Sumaila and Walters, 2005) of rebuilding overfished fish populations would include (i) direct use value;[4] (ii) indirect use value;[5] (iii) option value;[6] (iv) bequest value;[7] and (vi) existence value (Krutilla, 1967).[8] The estimates

[3] The use of NMFS' rebuilding scenarios for purposes of this study should not be viewed as an endorsement of these scenarios, some of which have been criticized as being overly long or risk-prone.
[4] Value of ecosystem goods and services that are directly used for consumptive purposes, e.g., the value of commercial output such as fish harvest.
[5] Value of ecosystem goods and services that are used as intermediate inputs to production, e.g., ecological services provided by an otherwise non-marketed species, for example, a species that is important prey for a commercially valuable species.

in this report include only the following direct use values: recreational values and the ex-vessel commercial values (value at the dock). It does not include, for instance, the economic values of rebuilding to processors and retailers. Inclusion of all these other values would involve a much more extensive analysis that is beyond the scope of this study. The study thus provides a partial estimate of the total value to be derived from rebuilding this subset of overfished stocks. A more extensive study would show the benefits of rebuilding to be even greater.

METHODS

Selection of stocks to be studied

According to the 2003 Report to Congress on the Status of U.S. Fisheries (May 2004), 76 federally managed fish stocks in U.S. waters were considered overfished in 2003. A stock is declared overfished when its abundance is below a prescribed biomass threshold. This study evaluated a subset of these overfished stocks based on their landed values. From the list of 76, we identified 24 "million dollar" stocks—stocks that have yielded at least $1 million worth of landings in any given year in the history of the fishery.[9] Landed value data published by NMFS (available at http://www.st.nmfs.gov/commercial/landings/gc_runc.html) were used to identify these stocks. We conducted the economic analysis on the 13 stocks for which sufficient data were available.[10] In addition, we included four additional overfished stocks (Georges Bank cod, Georges Bank yellowtail, Southern New England/Mid-Atlantic yellowtail and Gulf of Maine haddock) that are the same species as some of the million dollar stocks. Note: although Georges Bank yellowtail was not officially declared overfished in 2003, it was classified as "rebuilding" due to concerns regarding its status.

[6] The potential that the ecosystem will provide currently unknown valuable goods and services in the future.
[7] This value captures the willingness to pay to preserve a resource for the benefit of one's descendants (future generations).
[8] This is the value conferred by humans on the ecosystem regardless of its use value. This essentially is what is described as non-use value in the literature. This value may arise from aesthetic, ethical, moral, or religious considerations.
[9] The 24 stocks are Gulf of Maine cod, Bocaccio, Georges Bank haddock, Pacific ocean perch, black sea bass, golden tilefish, white hake, Southern New England/Mid-Atlantic windowpane flounder, bluefish, red drum, widow rockfish, Gulf group king mackerel, ocean pout, vermilion snapper, lingcod, yellow eye rockfish, Atlantic halibut, canary rockfish, greater amberjack, red snapper, American plaice, Southern New England winter flounder, Pacific whiting, Cape Cod/Gulf of Maine yellowtail flounder. (Pacific whiting was later found to have been declared overfished in error.)
[10] For example, black sea bass, red drum, and gulf group king mackerel had insufficient population data to formulate reliable rebuilding targets. Red snapper did not have an approved rebuilding plan and the rebuilding plans of Atlantic halibut, Bocaccio, tilefish, canary rockfish, and widow rockfish contained insufficient information for our analysis. In these cases, either TAC projections were not provided or their projections did not include maximum sustainable yield levels.

Alternative scenarios

Two scenarios were analyzed and compared. The baseline "recent catch" scenario reflected recent catches of populations of fish that are currently considered overfished. The projection of these catches, over the time frame of the study, is intended to represent an approximation of what might happen if these populations were not rebuilt to healthy levels and current catch levels continued into the future essentially unchanged. It should be noted that in the absence of data and information, this assumption represents a simplification of potential population dynamics.

In reality, future catch levels would most likely deviate from current catch levels. Some stocks could experience population growth because rebuilding programs have already been initiated and thus show an increase in catch levels. Others could likely suffer decreases in future catch levels because overfishing has been occurring in recent years–suggesting that current levels of fishing are unsustainable over time. The resulting over- and under-estimations will likely balance each other in the final estimation of the total NPV of economic benefits, as approximately half of the stocks examined were being overfished in 2003 and this remained the case in 2004 (NOAA, 2004, 2005). The rebuilding scenario, on the other hand, uses the projected total allowable catches (TACs) that are expected if currently adopted rebuilding plans are implemented.[11]

"Recent catch" was derived by taking the higher of two possible numbers, either the average catch (or landings, whichever one was reported by NMFS) for the most recent five-year period included in the current stock assessment, or the catch (or landings, whichever one was reported by NMFS) of the last year of this five-year period. The five-year time period typically ranges from 1997 through 2001, or from 1998 through 2002. The higher of the two numbers was taken to be on the conservative side, and to ensure that the comparison is not made with unrealistically depressed catch levels because of recent management changes.

Although NMFS generally supplies up-to-date catch or landings statistics in its databases, data was restricted to information published in the most recent stock assessments (NEFSC, 2002; Mid-Atlantic Fishery Management Council 2004; Hamel *et al.*, 2003; Jagielo *et al.*, 2003; vermilion snapper and greater amberjack catch statistics, Stu Kennedy, pers. comm.). These data are deemed more reliable because stock assessment review panels have worked on them.

For our "rebuilding" scenario, we utilized the currently adopted rebuilding plans developed by the Regional Fishery Management Councils and approved by NMFS (New England Fishery Management Council, 2003; Mid-Atlantic Fishery Management Council, 1998; Gulf of Mexico Fishery Management Council, 2002, 2004; Pacific Fishery Management Council, 2003). The rebuilding plans, fishery management plans, and related Environmental Impact Statements (EISs) include biomass rebuilding targets (B_{MSY}), rebuilding timeframes, and yearly total allowable catch estimates (TACs) throughout the rebuilding period. These estimates are principally the product of stock assessments and rebuilding plan analyses. Consequently, both the underlying data and estimation methods have been subject to review by fisheries biologists, fisheries managers, and professional fishers. Though biological

[11] TACs were utilized as opposed to Optimum Yields (OYs) because that is what NMFS typically provided in its EISs.

reference points and projected TACs may change when a stock is reassessed, the most recent stock assessment represents the best available information.

Economic valuation of different scenarios

The net present value of benefits generated by the commercial and recreational sectors under the recent catch scenario was computed and compared with the net present value of benefits that would be generated under the rebuilding scenario.

Prices of commercial catch

We assumed that ex-vessel prices are constant through time in the current analysis. U.S. ex-vessel prices for 2003, reported on the website of NMFS, http://www.st.nmfs.gov/commercial/landings/gc_runc.html, were applied. A close look at the forces that shape demand and supply of fish—and therefore the price—suggests that the constant price assumption is reasonable. On the supply side, one expects restoration, all things being equal, to result in higher yields in the future and therefore lower prices. Balancing this, however, is a likely increase in demand, resulting from rising incomes and increasing population, putting an upward pressure on prices. The dockside demand equations estimated in Amendment 13 of the Northeast Multispecies Fisheries Management Plan illustrate such a dynamic. In that analysis, the key variables, quantity supplied and time, impose opposing forces on price resulting in little change in price with time.[12] The assumption of constant prices in economic analyses, is in fact, common practice for bioeconomists.[13]

Cost of fishing by commercial sector

For stocks in the Northeast, Mid-Atlantic, and Gulf regions, we assumed the cost of fishing under our recent catch scenario to be 85 percent of total gross revenue and cost of fishing under the rebuilding scenario to be 70 percent of total gross revenue. These values are based on analyses conducted in Amendment 13 of the Northeast Multispecies FMP/Supplemental Environmental Impact Statement in 2003. Data in Amendment 13 showed that net income to groundfish vessels was approximately 15 percent of total gross revenue. This suggests that the cost of fishing, assuming labor earns no economic surplus, was 85 percent of gross revenues. Cost estimates from the same analysis showed that by the end of the rebuilding period, fishing costs were 70 percent of total gross revenue. As comparable data for the Mid-Atlantic, Southeast, and Gulf fisheries did not appear to be available, these cost estimates were used for those fisheries as well.

For the Pacific coast fish stocks, a cost of fishing of 90 percent for the recent catch scenario, and of 80 percent for the rebuilding scenario, were applied. This assumption was drawn from a Fisheries Economic Assessment that estimated the profit margin of large groundfish trawlers on the Pacific coast at approximately 10 percent before the

[12] Reported in Appendix 16-2 of Amendment 13 of the Northeast Multispecies FMP.
[13] See, for example, Clark (1990, Chapter 2).

recent buyback program.[14] More up-to-date information on the cost of fishing in this fishery is not readily available (Merrick Burden, pers. comm.), though the profit margin is expected to improve with the implementation of the buyout program. The cost assumed under the rebuilding scenario is in line with the difference in cost of fishing observed in the Northeast groundfish fisheries for the two scenarios.

Net commercial revenues from a fish stock

The net commercial value is the ex-vessel (dockside) value of commercially landed fish less the cost of fishing. To compute net commercial values, the unit net price— that is, the price less the cost of landing a unit weight of fish—was calculated first. The net commercial value in a given year is calculated by multiplying catch by the net price of a given stock (s). Hence, the net commercial value (*CV*) from a given stock (s) in a given year (*t*) can be expressed mathematically as:

$$CV_{s,t} = p_s * L^c{}_{s,t} \qquad (1)$$

Where p_s denotes the net price per unit weight of the stock and $L^c{}_{s,t}$ is the quantity of the fish (in weight) caught and landed commercially in year *t*.

Recreational revenues from a fish stock

There are insufficient data in the available literature to calculate the recreational revenues associated with rebuilding fish populations in a manner that is comparable to the calculation of commercial revenues. Rather than reducing accuracy by not including recreational revenues at all, this study relies on the very limited empirical analyses regarding the relative value of recreational fishing to commercial fishing values. A value used in the Northwest salmon fishery, which set net recreational values at five times that of net commercial values per unit weight (Dan Huppert, pers. comm.[15]), was applied. To be conservative, a sensitivity analysis under the assumption of a 1:1 net value from the catches of the two sectors, was carried out as well. It should be noted that, with two exceptions (bluefish and greater amberjack), for most of the populations analyzed in this study, the overwhelming percentage of the catch happens to be commercial, so recreational revenues do not represent a large portion of the total net present value of rebuilding that is calculated.

Recreational values were computed by multiplying the portion of a projected TAC for a species that is taken by the recreational sector by the net price of the fish stock times the recreational revenue multiple (α). The net recreational value (*RV*) from a stock (s) in year *t* can be expressed as

$$RV_{s,t} = \alpha * p_s * L^r{}_{s,t} \qquad (2)$$

Where p_s is as defined earlier and $L^r{}_{s,t}$ is the quantity of the fish stock caught by recreational fishers.

[14] 2004 Fisheries Economic Assessment Model undertaken by the Research Group. Corvallis, OR.
[15] Daniel Huppert, Professor School of Marine Affairs, University of Washington: Evaluating climate forecast value in fishery management: An application to the coho salmon (Oncorhynchus kisutch) fishery in Washington State. Presentation at a Workshop on the "Effects of climate change on fisheries", June 20-21, Bergen, Norway.

Net commercial and recreational values

Net commercial and recreational values (*TCRV*) is simply the sum of net commercial and recreational values, that is,

$$TCRV_{s,t} = CV_{s,t} + RV_{s,t} \tag{3}$$

Present values

For each of the stocks, we calculated the net present (commercial and recreational) value covering the rebuilding periods.

The net present value from a stock from both the commercial and recreational sectors is given by

$$NPV_{s,t} = \sum_{t=0}^{T} \frac{TCRV_{s,t}}{(1+\delta)^t} \tag{4}$$

T is defined as the terminal year of the rebuilding period. The parameter, δ , is the discount rate, which is given a value of 7 percent as recommended by the Office of Management and Budget, Executive Office of the President of the United States. Many consider this discount rate to be too high for analyzing the economics of environmental and natural resource management (e.g. Weitzman, 2001; Sumaila and Walters, 2005); therefore, sensitivity analyses testing how lower discount rates affected the results was carried out.

RESULTS AND DISCUSSION

We present in Table 1 the results for the 17 overfished stocks evaluated. Figures 2a, b, c, and d plot the results graphically for the top 15 of these stocks in terms of their NPV.

Table 1: Price, catch, and NPVs from alternative scenarios for select U.S. overfished stocks.

Stock	**2003 Price ($/tonne)**	**Total catch ('000 tonnes) Recent catch levels**	**Total catch ('000 tonnes) Rebuilding**	**Target rebuilding year**	**Recreational proportion**	**Total NPV (million $) Recent catch**	**Total NPV (million $) Rebuilding**
Atlantic cod GM	2572.2	7.78	16.63	2014	0.2	39.83	107.26
Bluefish	620.1	9.62	36.81	2007	0.83	10.8	41.09
Greater amberjack	1969	2.09	3.59	2012	0.72	15.1	37.17
Atlantic cod GB	2572.2	10.64	26.48	2026	0	46.74	109.11
Haddock GB	2501	4.64	19.81	2014	0	12.82	88.3
Yellowtail flounder GB	2542	4.3	7.24	2014	0	12.09	38.28
Yellowtail flounder SNE/MA	2542	0.9	11.96	2014	0	2.53	36.27
Winter flounder SNE/MA	2127	5.1	11.96	2014	0	12	26.71
Haddock GM	2501	1.19	5.06	2014	0	3.29	23.46
Pacific lingcod	2351	0.85	2.04	2009	0.18	1.5	6.98
American plaice	2592	4.43	4.64	2014	0	12.71	20.38
Vermilion snapper	4370	1.37	1.19	2013	0.05	7.38	9.05*
Yellowtail flounder CC/GM	2542	2.81	1.97	2023	0	11.45	11.32
White hake	1046	3.48	6.47	2014	0	4.03	10.42
Windowpane flounder (S)	832	1.52	0.9	2014	0	1.4	0.71
Ocean pout	814	0.016	0.077	2014	0	0.01	0.14
Pacific Ocean perch	71	0.41	1.16	2027	0	0.03	0.08
Total		61.15	**157.90**			**193.71**	**566.70**

* Note: Although vermilion catches decline in the rebuilding scenario, the total biomass of the stock is expected to increase significantly; thus the rebuilding cost assumption was used to calculate NPV. This is also the case for CC/GOM yellowtail flounder and southern windowpane flounder.

Figure 2a: Net present value under the recent catch and rebuilding scenarios in million dollars for Gulf of Maine Atlantic cod, Georges Bank Atlantic cod, and Georges Bank haddock.

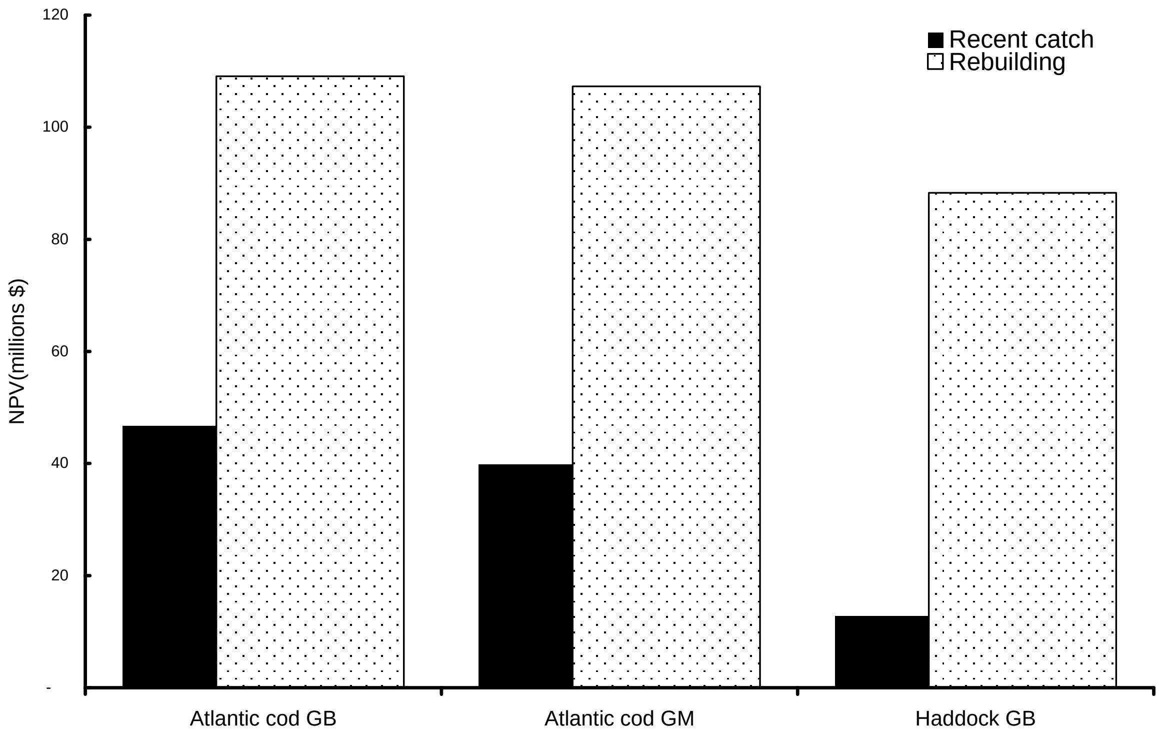


Figure 2b: Net present value under the recent catch and rebuilding scenarios in million dollars for bluefish, Georges Bank yellowtail, greater amberjack, SNE/MA yellowtail, and SNE/MA winter flounder.

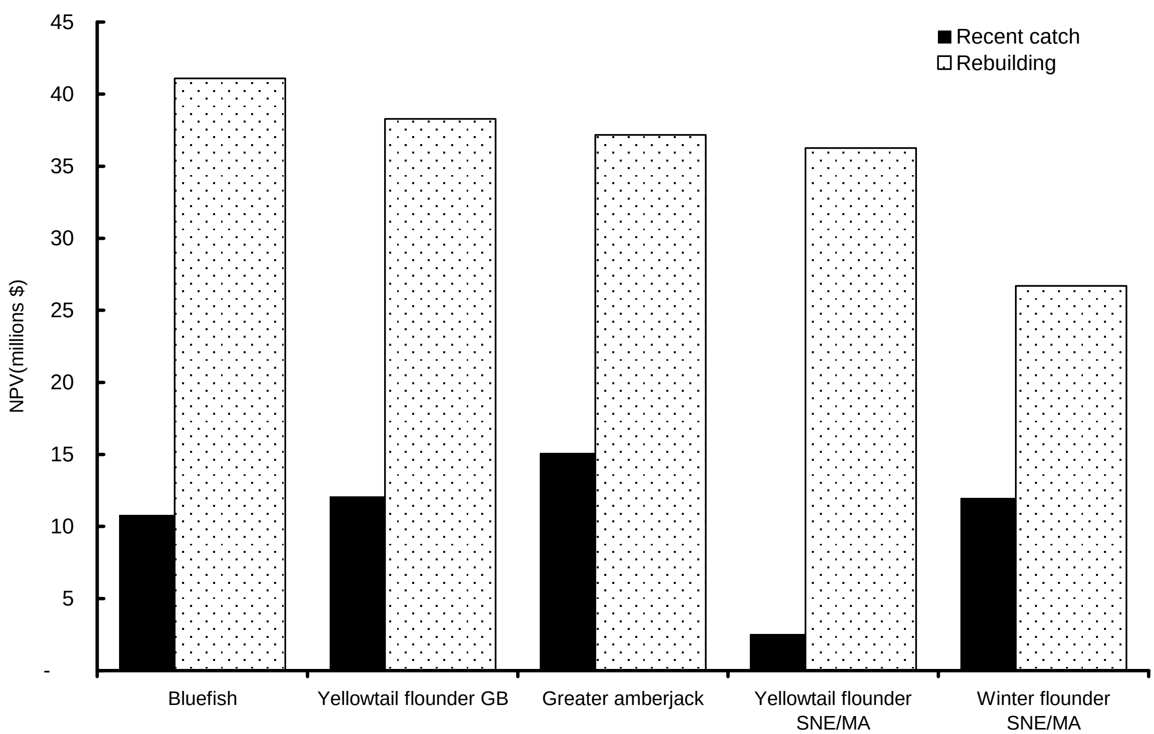


Figure 2c: Net present value under the recent catch and rebuilding scenarios in million dollars for Gulf of Maine haddock, American plaice, CC/GM yellowtail, and white hake.

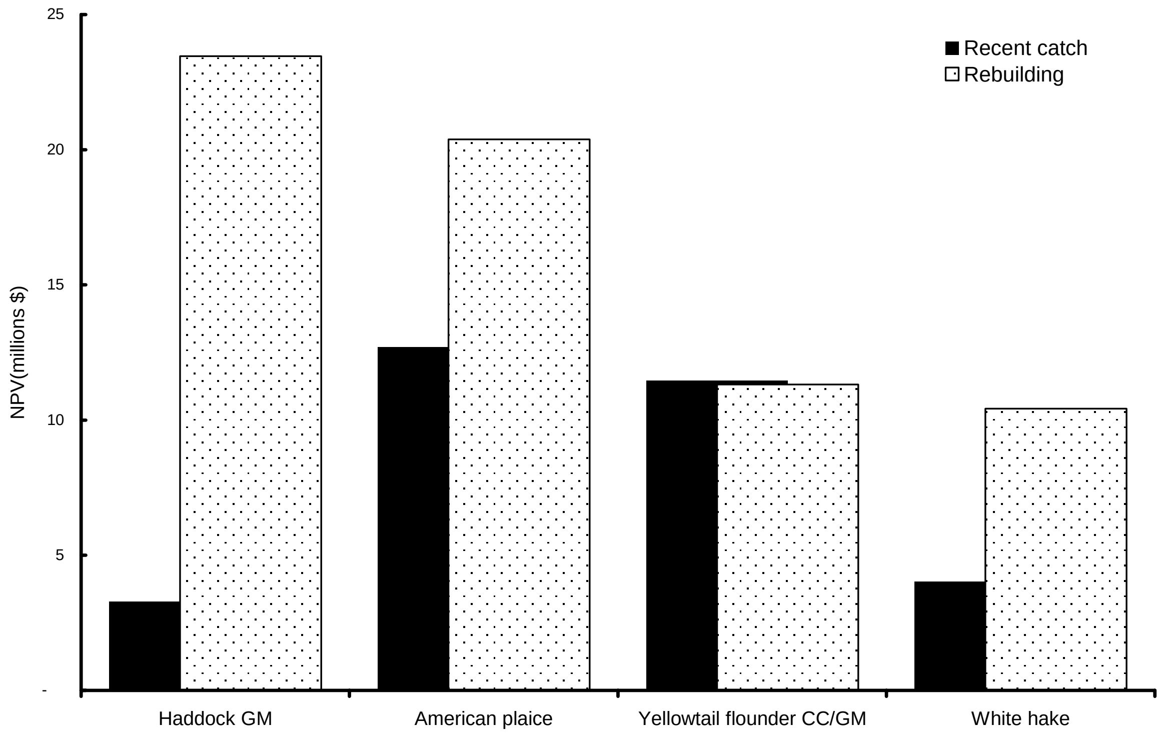
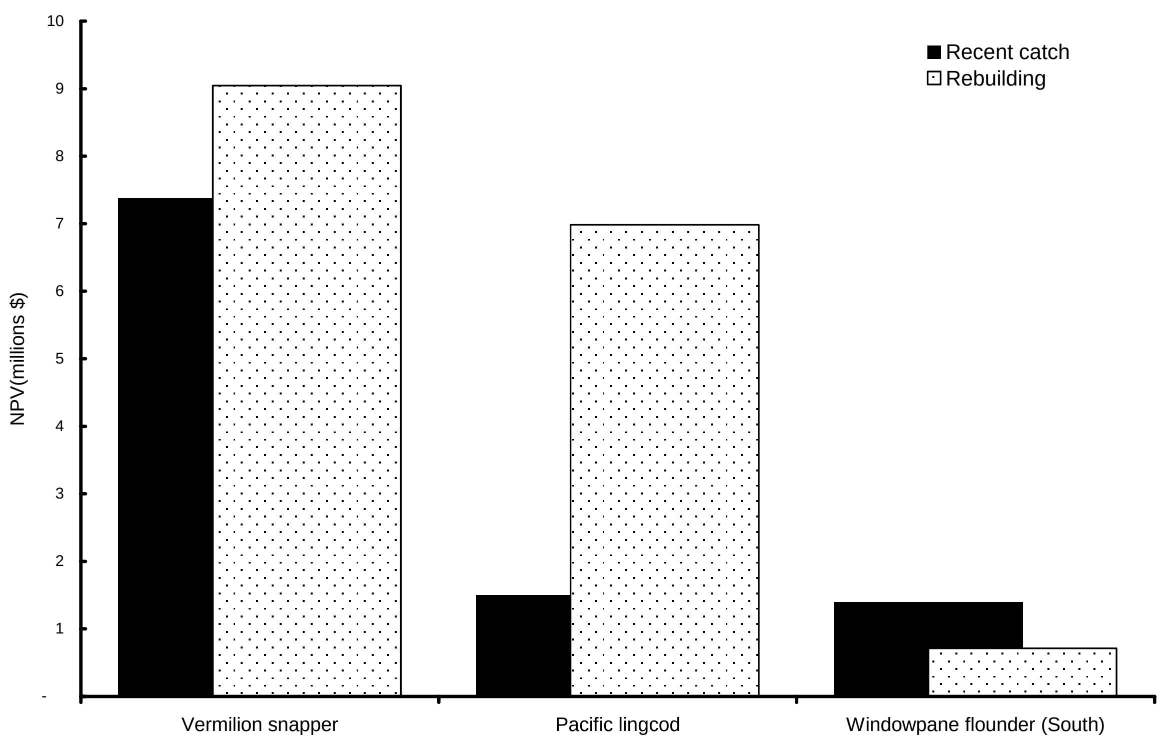


Figure 2d: Net present value under the recent catch and rebuilding scenarios in million dollars for vermilion snapper, Pacific lingcod, and windowpane flounder.



The following observations can be made from the analysis:

- Total catch of the 17 stocks studied increases by approximately two and one half times under the rebuilding scenario compared to the recent catch scenario.

- The NPV from all the stocks taken together under the recent catch scenario is $193.7 million, while the equivalent number under the rebuilding scenario is $566.7 million. Hence, for all 17 stocks taken together, the rebuilding scenario delivered approximately three times the NPV of the recent catch scenario.[16]

- The difference between the NPVs under rebuilding compared to recent catch ranges between -50 percent in the case of windowpane flounder (South), to more than 1400 percent in the case of yellowtail flounder (Southern New England /Mid-Atlantic).

- The net present value for all the stocks analyzed, with two exceptions, was higher under the rebuilding scenario than under the recent catch scenario. The two exceptions are windowpane flounder (South) and yellowtail flounder (Cape Cod/Gulf of Maine). The apparent explanation for this anomalous result is that, for some reason, the rebuilding targets for these stocks are at or below recent catch levels. Recent catch levels in the two stocks are believed to be too high in relation to recent stock size and are not sustainable, as evidenced by the fact that there has been overfishing in one or both of these stocks in recent years (NOAA, 2002; 2003; 2004; 2005). It is important to note that problems associated with the recent stock assessment of Cape Cod/Gulf of Maine yellowtail flounder are resulting in uncertain estimates of maximum sustainable yield in this stock.

- When a recreational versus commercial value multiple of one was assumed, the NPVs under the recent catch and the rebuilding scenarios were reduced to $155 and $455 million, respectively. However, the relative increase is similar to the base case.

- Sensitivity analysis on the discount rate indicates that the lower the discount rate, the higher the absolute and relative gains in NPV with rebuilding compared to the recent catch scenario. For instance, reducing the discount rate to 3 percent[17] increases the NPV to $241 and $723 million, respectively, under recent catch and rebuilding.

[16] Two reasons may account for the larger increase in NPV compared to total catch under the rebuilding scenario: (i) catch from the more valuable stocks increased proportionally more than catches of less valuable stocks, and (ii) catch per unit of rebuilt stocks deliver higher net benefits because it costs less to catch the fish.
[17] This is a discount rate that many (for example, Weitzman, 2001; Sumaila, 2004) will consider more appropriate for discounting goods and services from the natural environment.

CONCLUDING REMARKS

In summary, the findings show great potential for rebuilding plans to increate net present value from overfished stocks of the United States. In fact, the numbers reported in Table 1 and Figures 2a, b, c, and d represent only a fraction of the potential benefits of rebuilding, given that only a subset of stocks were analyzed and the economic analysis was restricted to direct use values. Although the analysis is subject to biological and economic uncertainties, it is still likely to represent an underestimate of the total economic value of rebuilding depleted U.S. fisheries. Consequently, from an economic point of view, it is worthwhile to stay the course with respect to current efforts at restoring overfished stocks of the United States. These results echo the conclusions of the Pew Oceans Commission Report that "Rebuilding U.S. fisheries has the potential to restore and create tens of thousands of family wage jobs and add at least 1.3 billion dollars to the U.S. economy." (Pew Oceans Commission, 2003, p. 5).

It is worth noting that 10 of the 17 stocks reviewed in this report were still being overfished in 2004 (NOAA, 2005). Although the number of overfished fisheries is continually changing, the potential for continuing loss of economic benefits is, indeed, real. While an important shift in fisheries management occurred with the reauthorization and amendment of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) in 1996, further investments in rebuilding fish stocks are necessary. This analysis suggests that not only is it economically worthwhile to stay the course with respect to current efforts to restore overfished stocks, but that much can be gained from strengthening such efforts.

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