Supplementary Information

Global fishery prospects under contrasting management regimes

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Methods

1. Raw Data Sources

Data for this analysis came from numerous publicly available databases; the RAM Legacy Stock Assessment Database (RAMLSADB)(1), the 2012 FAO fisheries capture production database (FishStat)(2), the 2009 *Review of the state of world marine fishery resources* (SOFIA) assessment database, and FishBase(3). Fisheries managed using property rights, referred to in this report as "catch shares," were identified, where possible, using the Catch Share database maintained by the Environmental Defense Fund (EDF), accessible online at http://catchshares.edf.org/database.

1.1. RAM Legacy Stock Assessment Database

The set of panel regression models used in this analysis were fit to data from the RAMLSADB, which will subsequently be referred to as the RAM database. Our analysis was performed using version 2.95 of the RAM database obtained in March 2015, which contains information from 504 stock assessments. Of these, 397 assessments, covering 188 species, provide time series of harvest and reference values. The included fisheries from the RAM database come from Australia, New Zealand, Canada, the USA, Peru, South Africa, Russia, Argentina, Japan, Europe, and numerous multinational stocks, many of which are for tunas and billfish. A complete list of the RAM fisheries included in the analysis is presented in Table S2.

1.2. FAO Global Marine Capture Production Database and SOFIA Assessment Database

Landings data for the remaining unassessed fisheries were drawn from the 2012 release of the FAO global fishery capture production database. These data can be accessed using the FishStatJ program publicly available from the FAO (http://www.fao.org/fishery/statistics/software/fishstatj/en).

Recognizing the limited scope of stocks covered by formal stock assessments, the FAO's 2009 *Review of the state of world marine fishery resources* (SOFIA) assessment database provides status estimates for the majority (80%) of global catch (4). The database contains 10-year catch histories (2000-2009) for 566 stocks, of which status estimates were present for 348 stocks. Stocks are classified into three categories: non-fully exploited (>60% virgin biomass (B_0)), fully exploited (40-60% B_0), and overexploited (<40% B_0).

1.3. FishBase

Life history data for each species in our unassessed fisheries database were queried from a static version of the publicly available FishBase database (http://www.fishbase.org/search.php) purchased from FishBase in March 2011 (the specific life history variables selected can be found in Table S3). In cases where multiple estimates of a life history variable were reported for the same species, we used the mean of these estimates. This was necessitated by the fact that it was not possible to automatically link region-specific estimates in FishBase to the location of specific unassessed fisheries in our database.

2. Data Processing

To obtain the most complete picture of the status of global fisheries, and the potential benefits of different recovery policies, our analysis combined all three databases described in Section 1. Missing geographic, taxonomic, and life history information were added for each fishery where possible. This compiled raw database was then filtered to the best of our ability to yield a single, inclusive dataset. The numerous criteria and assumptions required by this process are outlined in the following sub-sections.

2.1. Database Construction

We use landings data from the RAM, FAO, and SOFIA databases to create our database of global fisheries. Each fishery in our database is intended to represent a complete stock, however the spatial scale of stocks varies within and between the three databases. The RAM data offer the finest scale resolution, with large fisheries like Alaskan Pollock divided into numerous distinct stocks intended to reflect the biological range of the stock. In contrast, the FAO reports landings data as country-species combinations within an FAO statistical region (likely far larger than the true biological range of the stock in many cases), and SOFIA stocks are, in general, aggregations of catch from numerous countries within a given FAO statistical region.

In order to facilitate comparison across geographic regions and taxonomic groups, all stocks are assigned an FAO major fishing statistical region and an International Standard Statistical Classification of Aquatic Animals and Plants (ISSCAAP) code (Table S4, Table S5). Unlike the FAO and SOFIA databases, the RAM database assigns stocks to large marine ecosystems and does not report an FAO major fishing statistical region or ISSCAAP code. We assign FAO regions to RAM stocks based on the geographic location indicated by the 'areaname' variable in the RAM database. RAM stocks for which a single FAO region could not be determined from this information received all possible FAO regions (e.g., an "Atlantic" tuna fishery is assigned to statistical regions 21, 31, 27, 34, 31, and 47). RAM stocks were then assigned to their respective ISSCAAP category. Within several species categories, we aggregate reported catch for FAO stocks across all countries within FAO regions for the purposes of the catch trend analysis described in section 3. These species categories include 'Miscellaneous pelagic fishes', 'Tunas, bonitos, billfishes', and 'Cods, hakes, haddocks' (Table S5).

The timeframes of the data contained within the three databases are not aligned; the FAO database ends in 2012, SOFIA in 2009, and the RAM database varies by stock. In order to standardize the data to a common baseline year, all stocks ending prior to 2012 were extended to this date using the same data from the most recently available year. Lastly, for RAM stocks lacking life history information, and for all FAO and SOFIA stocks, the age at 50% maturity, Von Bertalanffy K, maximum length, and mean temperature of the species' range were obtained, when available, from FishBase.

2.2. Database Filtering

In order to avoid double counting in the final dataset, we took careful steps to identify and remove fisheries included in the multiple source databases. The identification of overlap relied on using the scientific name, country, and FAO major fishing statistical region of each fishery to find those that were represented in multiple databases. Fisheries from different databases that matched all three attributes were deemed to be redundant, and all but one entry was removed from the final dataset. Additionally, the country criterion was omitted when identifying overlap for "Multinational" RAM stocks where individual countries were not specified for the RAM fishery by the 'areaid' variable in the RAM database (Table S2).

Top priority was given to RAM data, with overlapping FAO and SOFIA data removed from the dataset, respectively. Individual FAO stocks were given second priority over SOFIA stocks for several reasons. The SOFIA database provides a single biological status estimate that is intended as an overall estimate of stock status and can be highly aggregated, often representing a biomass-weighted average of the status of substocks from many countries(4). Classification follows a hierarchical decision framework, ranging from formally adopted estimates from stock assessments to relying on indicators available in the "grey" or "black" literature. Additionally, only 10 years (2000-2009) of catch data are available. Because the SOFIA database does not include estimates of fishing mortality (F/F_{MSY}) or maximum sustainable yield (MSY) for stocks, model estimation of these parameters is still required. For these reasons, SOFIA stocks are only included where the catch histories of their component FAO stocks do not meet the data coverage standards required for inclusion in the analysis.

The catch quantities recorded in the RAM, FAO, and SOFIA databases are not always consistent for overlapping fisheries. While the RAM and FAO data are meant to account for commercial and recreational landings, the FAO data, in practice, almost exclusively accounts only for commercial catches(5). Additionally, issues of spatial and taxonomic resolution, quality of reporting, and rounding create further complications. For these reasons, the issue of overlap and the potential for double counting cannot be completely eliminated.

Each fishery must meet certain data coverage standards in order to be included in the analysis and the resulting final database. Fisheries that do not meet the necessary criteria are removed. These criteria, and other important assumptions regarding the inclusion of unassessed fisheries, can be found in the supplementary materials of Costello *et al.*(6). The final database includes 397 fisheries from the RAM database, 4,312 FAO fisheries, and four SOFIA fisheries.

3. Estimation of Current Biological Status (B/B_{MSY}), Fishing Mortality (F/F_{MSY}), and Maximum Sustainable Yield (MSY)

Estimates of MSY, g (the growth rate from the Pella-Tomlinson model(7)), B/B_{MSY} and F/F_{MSY} are required to represent the current status of a fishery and examine the future effects of possible management interventions. For RAM fisheries, these values were taken from the RAM database where available. In cases where only some of these reference values are provided, we used available values to calculate missing values (e.g., estimating MSY from Catch, B/B_{MSY} and F/F_{MSY}, and g as MSY/B_{MSY}). For all other unassessed fisheries, depending on the identification level, we perform two separate analyses to estimate these values. The first method combines a panel regression model(6) with a structural catch-based model(8), and is performed on fisheries identified to the species level. The second analysis extrapolates these estimates to the status of fisheries that are of lower taxonomic resolution and classified as "NEI" (not elsewhere included).

3.1. Panel Regression Model (PRM)

The PRM is performed largely following the methods in Costello *et al.*(6), but with several exceptions. First, we use the updated RAM data, which resulted in changes in the fits to the regression reported in Costello *et al.*(6). Second, the "Current year" variable was removed from the regression model, resulting in five available models rather than six. Removing the "Current year" variable was found to reduce the error around more recent estimates of fishery status. It was also highly collinear with the "inverse age" variable, and was likely skewing the ability of our model to predict the status of fisheries in regions unlike those encompassed by RAM (i.e., 1995 likely meant something very different for fish stocks in Africa than it did for Alaska). Table S3 contains the list of variables available for the five panel regression models. Finally, unlike Costello *et al.*(6), we include invertebrate fisheries among the species categories for which fixed effects are estimated. The summary statistics for each regression are included in Table S6-Table S11.

3.2. Catch-MSY

In order to obtain estimates of *MSY*, *g*, F/F_{MSY}, and B/B_{MSY} for unassessed fisheries, we employ a modification of the Catch-MSY method, which estimates *MSY* from catch data, "resilience" (translated to the growth parameter *g*) of the respective species, and assumptions about the relative initial and final depletion of the stock(8). The most substantial modification made to the methods described in ref (8) was the shift from the Schaefer model to a Pella-Tomlinson model(7) for the underlying population dynamics, described as:

$$B_{t+1} = B_t + \frac{\phi + 1}{\phi} g B_t \left(1 - \left(\frac{B_t}{K}\right)^{\phi}\right) - H_t \qquad (1)$$

where $\frac{\phi+1}{\phi} g$ is the intrinsic rate of the growth for the species (*g* is the population growth rate and ϕ is a scaling parameter), *K* is the carrying capacity, and H_t is the harvest rate in year *t*. We follow Thorson *et al.* (9) and set the ratio of $\frac{B_{MSY}}{K} = 0.4$, which corresponds to $\phi = 0.188$, per Equation 2.

$$\frac{1}{(\phi + 1)^{1/\phi}} = \frac{B_{MSY}}{K} = 0.4 \qquad (2)$$

Note that when ϕ =1 the model reproduces the Schaefer model. Thorson *et al.*(9) also provides separate $\frac{B_{MSY}}{K}$ ratios for the orders Pleuronectiformes, Gadiformes, Perciformes, Clupeiformes, and Scorpaeniformes. We include alternate global results for two analyses that evaluate different values of ϕ (see section 7.1). In Figure S2, ϕ =1 and results thus reflect the use of the Schaefer model. Figure S3 adopts order-specific ϕ values per Thorson *et al.*(9) . Since we have fixed ϕ, the remainder of Catch-MSY works in the same manner as ref (8), except that the model now evaluates a parameter space of *g* and *K* rather than *r* and *K*.

When applying the Catch-MSY method, we use the 45^{th} and 55^{th} percentile of the distribution of B/B_{MSY} estimates provided by the PRM model as informative priors on the stock's relative final depletion. The priors were constrained in this way to prevent Catch-MSY from preferentially selecting extremely high final B/B_{MSY} values (and associated high *MSY*s, because high *MSY*s will always be more viable if final depletion is not constrained). The prior on initial depletion for all stocks is set using the uniform distribution (U) at B/K U~ [0.6,1.0]. In some instances, the PRM model estimates a stock's final depletion to be $B/B_{\mathrm{MSY}} > (\phi + 1)^{1/\phi}$ (2.5 when ϕ is 0.188), which is inconsistent with the Pella-Tomlinson model and Catch-MSY framework. In these cases, the priors around final depletion were set at B/K U~ [0.7,0.85]. This truncation at 0.85 was selected as Catch-MSY's behavior becomes highly erratic when final depletion (B/K) is greater than 0.85.

For estimates of resilience, we classify stocks as having 'very low', 'low', 'medium', and 'high' resiliency based on available life history parameters and following the suggested classification in the literature(10) and on FishBase. Stocks lacking life history information from which to infer resilience were assigned 'medium' resilience. The four resilience classifications and corresponding priors on g are presented in Table S11.

The Catch-MSY model output provides, for each stock, log mean estimates of B/B_{MSY} and F/F_{MSY} through time, as well as MSY, g, and K. All necessary input parameters for the bioeconomic model are described in Section 4.

3.3. Aggregated "Not elsewhere included" (NEI) fisheries

The earlier work of Costello *et al.*(6) omitted NEI fisheries, which amount to approximately 35% of current global catch. Depending on the reported taxonomic resolution, these stocks can be included in an ISSCAAP category (e.g., "Hakes nei" included in 'Cods, hakes, haddocks') or included under the general ISSCAAP category 'Marine fishes nei' if taxonomic data are unavailable. For this analysis we exclude the fisheries contained within the "Marine fishes nei" category.

To account for the remaining NEI fisheries (n = 1,932) in the current analysis, we adopt an approach using the previously described method as the basic principle. The species composition of the included NEI fisheries is known, at best, only up to the genus level, and fluctuations in catch may be the result of changes in the nature of reported catch, or in some cases may represent the real signal of depletion(5). Therefore, we do not apply the PRM and Catch-MSY analysis directly, but rather apply values from taxonomically comparable species-level fisheries for which results are available.

To identify taxonomically comparable fisheries for each NEI fishery, we use the 2014 version of the FAO's AFSIS List of Species for Fishery Statistics Purposes. This list is publicly available at http://www.fao.org/fishery/collection/asfis/en. The AFSIS list is used to organize world capture and aquaculture production statistics at the species, genus, family, or higher taxonomic levels. For each of the 12,560 species items, the ASFIS list includes identification codes (ISSCAAP group, taxonomic, and 3-alpha codes) and taxonomic information (scientific name, family, and higher taxonomic classification).

Using the AFSIS list, we identify all possible species that fall under the taxonomic group indicated by a given NEI fishery. Once identified, we use this list of potential comparison stocks to query our global results for species-level stocks and assign the necessary parameters to the NEI fishery. For B/B_{MSY} and F/F_{MSY}, we assign the 25th and 75th percentiles, respectively, to the NEI fishery. For the remaining parameters (g, price, and cost), we assign the median values obtained from the comparison stocks. This process is repeated for each year and policy in the analysis. If no results are available from the potential comparison stocks, the NEI assemblage is dropped from the analysis. MSY for each NEI fishery is then calculated using the baseline year (2012) such that $MSY = \frac{C_{t0}}{\frac{B}{B_{MSY}}_{t0}\frac{F}{F_{MSY}}_{t0}}$, where C_{t0} is the actual catch of the NEI fishery in 2012.

3.4. MSY Adjustments

The estimates of *MSY* in our model were adjusted in two situations. First, forage fish populations are known to support many higher-trophic-level fisheries directly and indirectly, and it is unreasonable to assume that *MSY* can be achieved for all fisheries simultaneously(11, 12). For these reasons, we reduced the model estimates of *MSY* for all stocks in the "Herrings, sardines, anchovies" ISSCAAP category by 25%. We believe this to be a conservative reduction, as forage fish fisheries have been estimated to provide support services to other fisheries worth approximately 20% of the total value of world fisheries(11). Secondly, in instances where assessment values were unavailable and surplus production models produced unreliable estimates of carrying capacity (e.g., approximately infinite), the RAM database assumes carrying capacity to be 10 times the highest stock ever recorded. For these fisheries, *MSY* was conservatively set equal to the average annual lifetime catch of the fishery.

4. Bioeconomic Model

Our economic projection model is inspired by and grounded in the Kobe plot – a normalized space in which to compare across fisheries with very different characteristics. The two axes on a Kobe plot are 1) the current biomass relative to the biomass that would generate *MSY* (i.e., B/B_{MSY}) and 2) the current fishing mortality rate relative to the fishing mortality rate that would generate *MSY* if the biomass were at B_{MSY} (i.e., F/F_{MSY}). Any fishery can be plotted in this space, and the position of a fishery in the Kobe plot provides information on its current status (B/B_{MSY}) and its likely future trend (F/F_{MSY}).

Figure S12 shows the global Kobe plot containing all 4,713 fisheries successfully included in our analysis. Figure S13 through Figure S17 show the results for individual FAO major fishing statistical regions. Fisheries spanning multiple FAO regions are included in all associated Kobe plots.

We extend the Kobe plot approach by developing a simple bioeconomic model that operates in this space and allows us to forecast the trajectory of a fishery under different management options. This approach involves two linked models – a simple biological model that forecasts how B/B_{MSY} will change under different management scenarios that affect F/F_{MSY}, and an economic model that estimates profits for any trajectory in the Kobe plot space.

4.1. Biological Model

Consider again the basic logistic surplus production model (commonly referred to as the Pella-Tomlinson model) in Equation 1, where biomass transitions are given by:

$$B_{t+1} = B_t + \frac{\phi+1}{\phi} g B_t \left(1 - \left(\frac{B_t}{K}\right)^{\phi}\right) - H_t. \quad (3)$$

Sustainable yield for the fishery is given by:

$$H_t = \frac{\phi + 1}{\phi} g B_t \left(1 - \left(\frac{B_t}{K}\right)^{\phi}\right). \quad (4)$$

Under this model, it is straightforward to show that *MSY* at equilibrium is achieved when the fishery harvest rate is $F_{MSY} = g$, at which point the maximized yield is $H_{MSY} = MSY = \frac{gK}{(\phi+1)^{1/\phi}}$ and the species biomass is $B_{MSY} = \frac{K}{(\phi+1)^{1/\phi}}$.

Equation 3 can be transformed using the scaled variables: $b_t \equiv B_t/B_{MSY}$ and $f_t \equiv F_t/F_{MSY}$, so that the model requires only two biological parameters, g and ϕ, as follows:

$$b_{t+1} = b_t + \frac{\phi+1}{\phi} g b_t \left(1 - \frac{b_t{}^{\phi}}{\phi+1}\right) - g f_t b_t \qquad (5)$$

Under this model we can represent the dynamics of the fishery with only the reduced-form variables (b_t and f_t) and an estimate of the growth parameter, g. If the fishery is harvested at $f_t = f_{MSY}$, then $b_t = f_t = 1$ at equilibrium. This general model provides a solution to the first challenge to forecasting recovery – a model that can be used for a variety of fisheries that requires data that are broadly available.

It is important to note that we use this notation solely to simplify the description of the bioeconomic model, and that we recognize the variables *b* and *f* may have specific interpretations in fishery science outside of our model.

4.2. Economic Model

The annual payoff from fishing is given generally by the function $\pi(b_t, f_t)$. Under that payoff, one possible objective of fishery management is to determine a sequence of fishing mortality rates, $f_1, f_2, \ldots$ that maximize the discounted future stream of payoffs, as follows:

$$\max_{f_1, f_2, \ldots} \sum_{t=1}^{\infty} \frac{\pi(b_t, f_t)}{(1+\delta)^t} \qquad (6)$$

for discount rate δ and starting biomass b_0 given. In what follows, we will derive a particular functional form for the profit expression $\pi(b_t, f_t)$. In particular, suppose profit is given by:

$$\pi_t = pH_t - cF_t^{\beta} \qquad (7)$$

where *p* is ex-vessel price of fish, $H_t \equiv F_t B_t$ is harvest, *c* is a cost parameter, *F* is the fishing mortality rate, and β is a scalar cost parameter that determines how non-linear the costs are. Rewriting Equation 7 and substituting known parameters, we obtain the following profit expressions:

$$\pi_t = pMSY f_t b_t - c(f_t g)^{\beta} \qquad (8)$$

$$\pi_{MSY} = pMSY - c(g)^{\beta} \qquad (9)$$

To calculate *c*, we first identify unassessed fisheries estimated to be in bioeconomic equilibrium, which occurs when $f_t = \bar{f} = \frac{\phi+1}{\phi}\left(1 - \frac{b_t^{\phi}}{\phi+1}\right)$. We specify a tolerance, μ (0.2), such that a fishery where $\mu \geq |\bar{f} - f_t|$ is assumed to be in equilibrium. We then assume the biomass level at the open access equilibrium, $\bar{b}$, is equal to either the 10th percentile of this subset or 0.5, whichever is lower. For a fishery initially in open access equilibrium $\bar{b}, \bar{f}$, total profits are zero (at initial price, *p)*, which implies that the cost of fishing equals:

$$c = \frac{p\bar{f}\bar{b}MSY}{(g\bar{f})^{\beta}} \tag{10}$$

The parameter β governs the non-linearity of cost. When β >1 this implies that as units of effort are added to the fishery, they are increasingly costly. This would occur, for example, if the most efficient captains are the first to catch fish, and adding subsequent units of effort are less effective at catching fish.

4.3. Downward-Sloping Demand Function

We constructed a demand function in order to allow the price of fish in our model to fluctuate as a function of harvest. Our baseline assumption is that prices are a function of total global harvest, meaning that all species are part of the same global market and are perfect substitutes for each other.

A given global harvest q_t in year *t* gives rise to price for fishery *i* through the constant elasticity of demand function:

$$q_t = \alpha_i (p_{i,t})^e \tag{11}$$

where the parameter *e* is the constant elasticity of demand. Rearranging gives:

$$p_{i,t} = \left(\frac{1}{\alpha_i}\right)^{\frac{1}{e}} (q_t)^{\frac{1}{e}} \tag{12}$$

and the fishery-specific parameter α_i is calculated by:

$$\alpha_i = \frac{q_{t=2012}}{(p_{i,t=2012})^e} \tag{13}$$

For simulations, *q* is the quantity (MT) of global supply of fish, and *e* is set to -1.15, which accords with the range of price elasticities of demand for food fish suggested by Delgado *et al.*(13). Because the elasticity of demand parameter is negative, prices increase as global supply declines and decrease as supply increases. Figure S5 presents alternative global results if the demand function is perfectly elastic.

4.4. Bioeconomic Dynamics

In the absence of fishery management, an "open access" situation arises in which "effort" or "fishing mortality" enters and exits the fishery. Under the assumption that entry and exit to the fishery is proportional to current profits, fishing mortality in the next year, f_{t+1}, is as follows:

$$f_{t+1} = f_t + \lambda \left(\frac{\pi_t}{\pi_{MSY}}\right) \tag{14}$$

Note that when $\lambda = 0$ fishing mortality is constant through time. We adopt $\lambda = 0.1$ for simulating the open access dynamics of all fisheries and evaluate considerable error in this parameter in our Monte Carlo routine.

Now imagine that a fishery manager selects a policy function for managing the fishery. This could be as simple as a pre-determined exploitation rate, or it could be something more complicated. However it is derived, and whatever its functional form, let the policy function be given by $\hat{f}(b_t)$. That is, in year *t* if the manager observes (scaled) biomass b_t, they will choose policy $\hat{f}(b_t)$. When the manager does so, the biomass responds via Equation 5. So the system of equations is given by:

$$b_{t+1} = b_t + \frac{\phi + 1}{\phi} g b_t \left(1 - \frac{{b_t}^{\phi}}{\phi + 1}\right) - g f_t b_t \tag{15}$$

$$f_{t+1} = \hat{f}(b_{t+1}) \tag{16}$$

which completely characterizes the dynamics of this bioeconomic system. Note that in steady state, $f_t = \frac{\phi+1}{\phi}\left(1 - \frac{b_t^{\phi}}{\phi+1}\right)$. The intersection of that "biological" isocline with the policy function $f = \hat{f}(b_t)$ gives the steady state of the bioeconomic system.

4.5. Summary of Default Inputs and Outputs of Bioeconomic Model

For any given fishery, we will require the following inputs:

- Initial conditions in the fishery: (scaled) b_0 and f_0
- Pella-Tomlinson shape parameter, ϕ
  - We assume $\phi = 0.188$ as per Thorson *et al.*(9)
  - Alternate global results using the Schaefer model ($\phi = 1$) are presented in Figure S2
  - Figure S3 provides results of an alternate analysis that adopts order-specific ϕ values also derived from Thorson *et al.*(9)
- Maximum sustainable yield, *MSY*
  - For non-RAM stocks, *MSY* is obtained from the output of Catch-MSY
  - For RAM stocks, to which Catch-MSY is not applied, *MSY* is taken from the RAM database
- The growth rate, *g*
  - For non-RAM stocks, *g* is obtained from the output of Catch-MSY
  - For RAM stocks, to which Catch-MSY is not applied, *g* is estimated from *MSY* and B_{MSY} such that $g = MSY/B_{MSY}$
- Price of fish, *p*
- Cost parameter, *c*
- Cost scaling parameter, β
  - We assume $\beta = 1.3$, which implies that increasing units of effort are increasingly costly to apply
  - Figure S4 provides alternative global results obtained by setting $\beta = 1$ and thus assuming costs scale linearly with fishing mortality
- Price elasticity of demand, *e*
  - We assume $e = -1.15$
  - Figure S5 provides alternate global results if the global demand in a single global market is perfectly elastic

- Discount rate, δ
  - The primary results presented in the manuscript were obtained using a 0% discount rate and compare policy outcomes in 2050
  - Figure S7 represents alternative global results obtained by optimizing policies around a 5% discount rate
- Open-access *f* adjustment parameter, λ
  - We assume $\lambda = 0.1$
  - Alternative values of λ are included in the Monte Carlo routine described in Section 7

For each fishery, and each harvest policy, we save the following model outputs:

- Biomass (*B*) and B/B_{MSY} over time
- Harvest (*H*) over time
- Fishing mortality (F/F_{MSY}) over time
- Profit π over time

The sensitivity of our model outputs to uncertainty and alternate assumptions for the above input parameters was thoroughly evaluated and is discussed in sections 7.1 and 7.2.

4.6. Projections for NEI fisheries

We project the raw values of harvest (*H*), biomass (*B*), and profit (π) for included NEI fisheries as follows:

- Maximum Sustainable Yield (*MSY*): *MSY* for each NEI fishery is calculated in the baseline year such that $MSY = \frac{H_{t0}}{b_{t0} f_{t0}}$, where H_{t0} is the actual harvest of the NEI fishery in that year and b_0 and f_0 are drawn from taxonomically comparable stocks
- Harvest: For harvest in projected years, $H_t = MSY f_t b_t$
- Biomass: Using b, $B = bMSY/g$, where g is the median intrinsic growth rate among the comparison stocks
- Profit: $\pi_t = p_t MSY f_t b_t - c(f_t g)^{\beta}$, where p is the median price from the comparison stocks in that year, c is the median cost parameter for the stocks, and g is the median growth rate among the comparison stocks

5. Policy Alternatives and Scenarios

We apply the bioeconomic model described in Section 4 to three alternative policy options for each fishery. We then estimate the gains from recovery under two scenarios: 1) policies are applied only to those fisheries of conservation concern and, 2) policies are applied to all fisheries.

5.1. Policy Alternatives

While there are thousands of possible harvest trajectories, we adopt three policies that capture a very wide range of possibilities, can be calculated for any fishery for which the required input parameters are available, and allow us to judge the relative merits of different harvest strategies. One can imagine justifying each of these policies on different grounds, and indeed, attempts have been made to emulate each of these strategies in different fisheries. The three policies evaluated in our model are the following:

- **F_{MSY} Policy (F_{MSY}):** Fish at F_{MSY} ($f = 1$) forever
- **Optimal Rights-Based Fishery Management Policy (RBFM):** Follow the harvest trajectory that maximizes the net present value (NPV) of profit in the fishery over a long time horizon. This harvest trajectory is different for each fishery and is a *policy function* or *control rule*, $f^*(b)$. This implies that recovery is "optimal" from an investment perspective – no other harvest path can achieve higher NPV of that fishery. Eventually, the fishery will reach a steady state biomass and fishing rate. Additionally, the ex-vessel price and variable cost of fishing are modified to reflect the efficiency gains of a rights-based program(14) as follows:
    - Ex-vessel price (p) increases from current value by 31%
    - Cost parameter (c) decreases from current value by 23%

  We adopt mean values obtained from a literature review of peer-reviewed studies examining these efficiency gains and evaluate our model's sensitivity to these parameters with several analyses (Table S13, Figure S10, Figure S11).

- **Business As Usual (BAU):** Because numerous options exist for defining a BAU policy, and fisheries in our database differ in current management, it is not appropriate to assign the same BAU policy to all fisheries. Instead, we adopt one of three policy alternatives depending on the current management for each stock.
    - Catch share fisheries: For known catch share fisheries we apply "RBFM" as the BAU policy
    - RAM fisheries (non-catch shares): For fisheries from the RAM database not identified as catch share fisheries, we apply the current fishing mortality in each fishery ($F_{Current}$) as the BAU policy
    - All remaining: Fisheries that are neither catch shares nor RAM are assumed to follow open access dynamics as the BAU policy

For projections under the RBFM and F_{MSY} policies, we assume fisheries do not adjust their harvest policies to reflect dynamic changes in prices resulting from changes in supply. Profits for these scenarios are adjusted in any given year by appropriately modifying price as a function of the total supply of catch in a given year. However, fishing effort of the open access fleets under BAU scenarios is governed by profits in the prior year. Therefore, for the open access fisheries we recalculate fishing mortality in each time step to account for changes in profitability resulting from shifts in price as a function of supply.

To demonstrate the application of the described policies, Figure S1 provides an illustration of a sample fishery. Starting with a status of overfished with heavy overfishing occurring (parameters in Table S1), the fishery is projected forward under the different policies (1) F_{MSY}, (2) economic optimal, and (3) BAU (open access).

5.2. Projection Scenarios

When examining the aggregated results achieved by each policy alternative, we consider the following two scenarios:

- **Stocks of Conservation Concern (CC):** For this scenario, the three policies are applied to all RAM and identified catch share fisheries, as well as to all fisheries where either current $B/B_{MSY} < 1$ or current $F/F_{MSY} > 1$. This classification corresponds, in general, to the FAO's classification of "overexploited" and "fully exploited" fisheries(4).
    - Under this scenario, to allow for aggregate values of harvest, biomass, and profit to still reflect all fisheries in the analysis, fisheries where $B/B_{MSY} > 1$ and $F/F_{MSY} < 1$ are projected such that B/B_{MSY} remains constant.

- **All Stocks:** For the second scenario, the policies are applied, regardless of current status, to all stocks included in the analysis.

The future benefits in harvest, biomass, and profits are calculated, for each policy and scenario, relative to current values and to that of the BAU policy. The results in the main text were derived using a 0% discount rate, however, optimizing policies around a 5% discount rate was also evaluated (Figure S7).

5.3. Multinational Stocks

Within the analysis exist numerous fisheries that represent landings from multiple countries, including 147 RAM fisheries listed as "Multinational" (Table S2), and 560 FAO stocks for which catch histories were aggregated by FAO region (see Section 2.1). In order to distribute the benefits these fisheries receive from each policy to participating countries, we use the FAO data to first identify all countries that reported landings for that species in the same FAO region. We then calculate the percent of harvest contributed by each country over the five-year period between 2008-2012, and apply these percentages to the future harvest, profits, biomass, and *MSY* of the multinational fishery. Because the exact countries participating in a given multinational RAM fishery are unknown, this protocol may, in some cases, misrepresent the true contribution of certain countries. For several RAM stocks, the scientific name of the stock does not match any reported FAO stocks, and participating countries can thus not be identified. This subset of stocks remains reported in the final dataset as "Multinational". Additionally, 37 high seas tuna stocks are included in the RAM database. Due to the political complexity of managing these stocks, we report these stocks as "High Seas Tuna and Billfish" and do not distribute recovery benefits to individual countries.

6. Economic Parameters

Ex-vessel prices received by fishers and their fishing costs are required for any analysis that attempts to understand the economic implications of behavior changes in the world's fisheries. Unfortunately, the existing databases of ex-vessel prices and costs are incomplete, widely scattered, and often publically unavailable to researchers(15, 16). Additionally, previous analyses have shown large variation in prices and costs across regions, with fishing costs also varying considerably by gear types(15, 16). Ex-vessel prices reflect the value received by fishers for their harvest and are thus critical for understanding and predicting fishing behavior. In order to provide a globally representative set of ex-vessel prices with which to analyze the economic effects of fishery reform, we adopt a novel approach using export data from the FAO and published estimates of average ex-vessel values by ISSCAAP category. The published ex-vessel values originate from "Appendix II – World fishery production: estimated value by groups of species" (available online at ftp://ftp.fao.org/FI/STAT/summary/appIIybc.pdf), with values representing weighted average values over all species within the category. Using FAO export data (value and quantities) for fisheries commodities, we aggregate commodities into groups that reflect individual species, groups of species, or ISSCAAP root categories. We then apply an inverse price expansion factor of exvessel:export price ratios to the aggregated commodity export price time series. These expansion factors are at the level of ISSCAAP root categories; a key assumption is that the percent added value between steps of landing fish and exporting fish is consistent across species within each ISSCAAP category.

Another important assumption of our model is that, under the RBFM policy, rights-based management generates economic efficiency gains in the form of higher prices and reduced costs. These economic gains are well documented in the literature and can arise from the ability of a rights-based system to allow for a more efficient allocation of resources within the fishery(17). Longer fishing seasons, fresher and more valuable product forms, and market power have all been shown to contribute to price increases in fisheries with rights-based management(18, 19). Lower fishing costs have been associated with reductions in fleet capacity and more efficient use of inputs following the implementation of rights-based management(20, 21). To include an economic effect in our rights-based fisheries management policy (RBFM), we surveyed the literature and adopted the mean reported price increase (31%) and cost reduction (-23%). Table S13 provides a summary of these references, which all cover fisheries managed with "Individual Transferrable Quota" (ITQ) systems.

7. Robustness Checks

The numerous robustness checks and sensitivity analyses conducted in support of our model's results are outlined below. Key takeaways of each section are identified by a bullet-point where appropriate.

7.1. Effects of Alternative Model Configurations

- Use of the Schaefer model reduces biomass estimates relative to estimates produced by the Pella-Tomlinson model. Use of a linear cost function ($\beta = 1$) or a 5% discount rate decrease biomass under the RBFM policy. Perfectly elastic demand increases profit differences between policies applied to conservation concern and policies applied to all stocks. Omitting NEI fisheries lowers estimates of biomass, harvests, and profits and improves the profitability of the BAU policy

Global results were explored for a handful of alternate parameterizations of the model. When $\phi = 1$ the biological model reproduces the Schaefer model, where B_{MSY} occurs at 50% of K. The primary effect of this scenario is to reduce the estimates of total biomass under all policies relative to results presented in the body of our paper (Figure S2). Note that Catch-MSY is able to fit fewer fisheries under this $\phi = 1$ scenario. Additionally, adopting order-specific ϕ values from Thorson *et al.*(9) has very little effect on our results relative to the results presented in the body of our paper, though again fewer stocks can be fit under this scenario (Figure S3).

Numerous alternate economic assumptions were also evaluated. When $\beta = 1$, costs increase linearly in relation to fishing mortality. The primary result of this scenario is to reduce total biomass under the RBFM policies, as the decreased costs make increased levels of fishing more profitable relative to the results presented in the body of our paper (Figure S4).

If the demand function is perfectly elastic rather than downward sloping, prices are not adjusted as a function of global fish supply. The primary effect of omitting a downward sloping global demand curve is an increase in the profit differences between the scenarios where policies are applied to conservation concern stocks and where policies are applied to all stocks. These differences relative to the results presented in the body of our paper are due to the lack of compensatory effects between catches and prices (Figure S5).

In order to further explore the dynamics of global fish supply and price, we follow Delgado *et al.*(13) and construct five global demand curves to evaluate a scenario where species are only substitutes for species of a similar type. We first aggregate ISSCAAP groups to one of five categories, 'Low-value finfish', 'High-value finfish', 'Crustaceans', 'Mollusks', or 'Other marine animals', each with its own global demand curve. The fifth category, 'Other marine animals', includes ISSCAAP categories not covered by ref(13). ISSCAAP categories and their assigned commodity categories are included in Table S12 and the global results of applying these five global demand curves are presented in Figure S6. Modifying the demand function to include distinct global markets for these five fisheries commodities categories has the effect of increasing profits under the BAU policy when applied to all stocks relative to the results presented in the body of our paper (Figure S6). Lastly, the primary effect of optimizing policies using a 5% discount rate is to decrease biomass in 2050 under the RBFM policies, relative to results presented in the body of our paper (Figure S7).

NEI fisheries constitute an important, and sometimes entire, component of many countries' fisheries. However, while omitting NEI fisheries from the analysis may affect the results for a given country, it does not dramatically alter the global results; fishery reform measures perform better than the BAU scenario in all three dimensions (Figure S8). The omission of the 1,932 NEI fisheries lowers our estimates of annual global profits, catch, and biomass for all policies. This outcome increases the relative performance with respect to profits of the BAU policy when applied to all stocks relative to results presented in the body of our paper. Projections for individual countries differ from the results presented in the paper body more than for the global results.

Lastly, Figure S9 provides alternate recovery trajectories for each policy if $B/B_{MSY} >= 0.95$ is used as the recovery threshold rather than 0.8 as presented in Figure 4 of the manuscript.

7.2. Parameter Sensitivity

- Monte Carlo routines show our estimates of total catch are relatively insensitive to uncertainty in price, costs, growth rates, and carrying capacity while our estimates of total profits are much more sensitive. Estimates of total profits, biomass, and catch in 2050 vary as a function of biological and economic parameter uncertainty, but do not change in order of magnitude within policies or rankings among policies

We performed two Monte Carlo routines to evaluate the sensitivity of components of our final results (e.g., change in catch, change in profits.) to the uncertainty resulting from Catch-MSY and other key parameters of our analysis.

The first Monte Carlo routine only evaluates stocks that were run through Catch-MSY, which provides a range of plausible pairs of g and MSY (often thousands of individual estimates for each fishery). For each iteration of the Monte Carlo (n=250), we drew random g and MSY pairs from Catch-MSY for each fishery and also apply a multiplicative uniform error term (~U[0.75,1.25]) to price, B/B_{MSY} at open access (which implicitly affects costs), and the "RBFM effect" (the price and cost changes resulting from moving to an RBFM policy).

Our estimates of total catch in 2050 vary greatly among policies (as they are intended to do), with the highest catches coming from F_{MSY}, and lowest catches (and highest uncertainty in catches) under BAU. For both scenarios, total catch in 2050 under the BAU policy is much more variable than the F_{MSY} or RBFM policies (Figure S10). Our 2050 distributions of profits retained the relative rankings of profitability by policy demonstrated in the paper. Profits were consistently lowest under both BAU scenarios, with the mean profits of the scenario applying BAU to all stocks approaching zero. The RBFM and F_{MSY} policies retained their statuses as the most profitable under the Monte Carlo, respectively. However, the magnitude of these profits varied substantially among iterations, by over 5 Billion dollars in some instances under RBFM. Total profits under BAU policies had a 15 Billion dollar range, but were always lower than F_{MSY} or RBFM (Figure S10). This suggests that the relative rankings and orders of magnitude of our RBFM and F_{MSY} policies, with respect to future profits, are stable, but our BAU estimates of profits are much more uncertain. Our estimates of total future profits (and NPV if a non-zero discount rate is applied) themselves are much more uncertain than our estimates of future catch.

The first Monte Carlo routine provides an assessment of the broad degree of variability in our metrics of interest resulting from reasonable uncertainty in our parameter values from the paired PRM/Catch-MSY process. However it does not directly reflect the potential uncertainty in the results reported in the body of the paper, since it does not include RAM or NEI stocks for which Catch-MSY was not directly applied. In order to address this, we performed an additional Monte Carlo routine (n=50) in which we introduced an individual uniform random multiplicative error term to all parameters of interest (~ U[0.75,1.25]) for all stocks included in our analysis. The parameters tested are MSY, g, price, β, λ, B/B_{MSY} at open access (effectively costs), catch-share price and cost effects, B/B_{MSY} of each stock in 2012, and the 2012 F/F_{MSY} calculated by $\frac{F}{F_{\mathrm{MSY}}} = (\frac{\mathrm{Catch}}{MSY} * \frac{B_{\mathrm{MSY}}}{B})$. Together these terms represent the primary drivers of our estimates of current and future profits, yields, and biomass. We then projected each stock forward for each policy in the same manner as described in the paper, producing a distribution around our projections of current and future profits, yields, and biomass.

Results of the second Monte Carlo show that, while the point estimates of the total outcomes of any individual policy are variable, the general magnitude of each of the policies with respect to global profits, catch, and biomass, does not meaningfully change as a result of introducing significant uncertainty into the key parameters of our model, when compared to Figure 3 from the body of our paper (Figure S11). Most policies showed a spread in total profits of $10 Billion and 100 MMT of total biomass. Total catches in 2050 varied very little within policies. The results of this expanded Monte Carlo show that most of our policies produce similar global results when substantial uncertainty is applied to all key parameters, both economic and biological, in the model.

7.3. Current Status

- Our median estimates of current status vary considerably by FAO region, ranging from 0.56-1.18 for B/B_{MSY} and from 0.5-2.43 for F/F_{MSY}. Jackknifing routines show that we are, on average, underestimating B/B_{MSY} and *MSY* by 20% and 50% respectively. Our F/F_{MSY} estimates are positively biased often by 75% or more.

Kobe plots for the world's fisheries and individual FAO regions are presented in Figure S12 through Figure S17 and show considerable variation. Median B/B_{MSY} is estimated to be below 1 for all regions except the Northeast Pacific. Conversely, median F/F_{MSY} exceeds 1 in all regions except the Northeast Pacific and Northwest Atlantic. However, catch-weighted average status (green squares) shows that, when accounting for fishery size, current B/B_{MSY} is generally higher in all regions while F/F_{MSY} is more variable.

We performed two jackknife routines to evaluate the ability of our model to predict out of sample. For both routines, we consider only RAM stocks, as these are the only instances we have "true" values for the parameters of interest (*MSY*, B/B_{MSY}, F/F_{MSY}). We first performed an individual jackknife by sequentially removing each RAM stock (n=397) from the regression block and re-estimating the PRM. We then predicted the status of the omitted stock using the re-estimated regression. This predicted status was passed to Catch-MSY as the prior on final depletion, and the resulting predictions for B/B_{MSY}, F/F_{MSY}, and *MSY* for the omitted RAM stock were stored. Our median proportional error in B/B_{MSY} in 2012 (the primary year of interest) was ~ -20%, suggesting that for the median fishery we are underestimating B/B_{MSY}. The results suggest that our estimates of B/B_{MSY} are on average negatively biased, but that there is substantial variation in the direction and magnitude of this bias for any individual fishery (Figure S18). The proportional error in our estimates of B/B_{MSY} is uncorrelated with catch in any given year, but highly influenced by the "true"" B/B_{MSY}. Specifically, we severely over-predict the B/B_{MSY} for highly overfished RAM stocks (i.e. when "true" B/B_{MSY} is less than 0.5), and under-predict B/B_{MSY} when true B/B_{MSY} is high. The F/F_{MSY} values from our individual jackknifing are highly positively biased, and have substantial amounts of error (Figure S19). The *MSY*s estimated through our individual jackknifing routine indicate that we are underestimating *MSY* out of sample, with a mean underestimate of 50%. However, there appears to be little correlation between our error in *MSY* and the size of the fishery (as defined by lifetime catch), indicating that, out of sample, we underestimate *MSY* for most of the RAM stocks regardless of size.

We also performed a regional jackknifing routine by sequentially removing all the RAM stocks in each unique region (roughly country) in RAM. We then re-estimated the PRM, omitting all of the RAM stocks from that region from the regression block, and then predicted the stocks in the omitted region. The predictions were then passed to Catch-MSY, and the individual predictions for *MSY*, B/B_{MSY}, and F/F_{MSY} for each omitted fishery are stored. Our broad results on the out-of-sample error in B/B_{MSY}, F/F_{MSY}, and *MSY* did not substantially change from the individual jackknifing. The regional out of sample predictive power of our estimate of *MSY* shows a negative bias across all regions, providing further evidence that we are likely to be underestimating *MSY* for most countries (Figure S20).

7.4. Illegal, Unreported, and Underreported Landings (IUU)

- IUU has little effect on estimated B/B_{MSY} and F/F_{MSY}, but has an almost perfectly linear effect on *MSY*; if catch is in fact 25% higher than reported, *MSY* rises by 25%. Thus, our estimates of *MSY* are likely to be conservative if chronic under-reporting of catch is occurring

Stock assessed fisheries make up a substantial portion of the catch and global *MSY* in our analysis. However, 92% of fisheries, 57% of catch, and 53% of *MSY* in our analysis are derived from unassessed fisheries (as of 2012), through our paired PRM-Catch-MSY process. The quality of catch records for these unassessed fisheries is highly variable, and in many instances misreporting occurs. This may take the form of IUU fishing, which would mean that more catch is occurring than is being reported, over-reporting of catches (as occurred with Chinese catches), or random misreporting. Given the recent focus on the problem of IUU, we tested the robustness of our estimates of B/B_{MSY}, F/F_{MSY}, and *MSY* to the presence of IUU.

Both the PRM and Catch-MSY depend on the reported catch history in order to reach results; while life history variables are included, the catch is the basis of the method. We increased the catches of each unassessed stock by 25% and then re-estimated B/B_{MSY} using the PRM with the new IUU adjusted catch. The IUU based estimates of B/B_{MSY} were then fed to Catch-MSY as the priors on final depletion, and *MSY*, F/F_{MSY}, B/B_{MSY}, and *g* were estimated. These metrics resulting from the IUU adjusted catch were then compared to the original values estimated with the raw reported catch data. Our results indicate that an IUU level of 25% has on average no effect on our estimates of B/B_{MSY} and F/F_{MSY}, though it does introduce unbiased error (Figure S21). Our estimate of total *MSY* is on average linearly related with IUU; when catches were increased by 25%, most fishery's *MSY* also increased by 25%, though some fisheries saw a greater increase in *MSY*. Our results indicate that if IUU, in the form of systemic under-reporting of catch, is present, our methods are likely to underestimate *MSY*. This suggests that if under-reporting of global catch is occurring our estimates of *MSY* are conservative.

7.5. Price and Cost Validation

Figure S22 shows the relationship between the prices used in our model and prices obtained from fishery management agencies in the US, Canada, New Zealand, and European Union (*n*=421 time series). The comparison is between estimated prices for individual species only. The Pearson correlation coefficient for the relationship is 0.56. The relationship suggests the prices used in the analysis are reasonable approximations and, in general, conservative estimates of true ex-vessel prices (Figure S22).

Fishing costs used in the analysis, which are modeled following the protocol described in Section 4.2, represent variable costs and are unable to account for fixed costs. Table S14 shows the cost/revenue ratios and cost-per-ton results for each ISSCAAP category. These results suggest that costs, and thus profits, vary considerably between ISSCAAP groups. The average fishing cost-per-ton for most ISSCAAP categories is consistent with the variable costs of fishing reported by Lam *et al.*(16) who estimated the global average variable cost per ton to range from $639-$1,217 USD.

7.6. Reproducing Historic Trends

We performed a historical analysis with our model to evaluate our ability to reproduce the outcomes observed in assessed fisheries. RAM data (B/B_{MSY}, F/F_{MSY}) from 1980 (or the earliest available year) served as the initial conditions for the analysis. Results compare the predicted log mean harvest over the time period against the observed log mean harvest over the same time period for each fishery. The model's predictions compare very well with the actual catch quantities observed over the same time period (Figure S23; correlation = 0.99, *p-value* < 1%, R^2 = 0.88).

Supplementary Figures

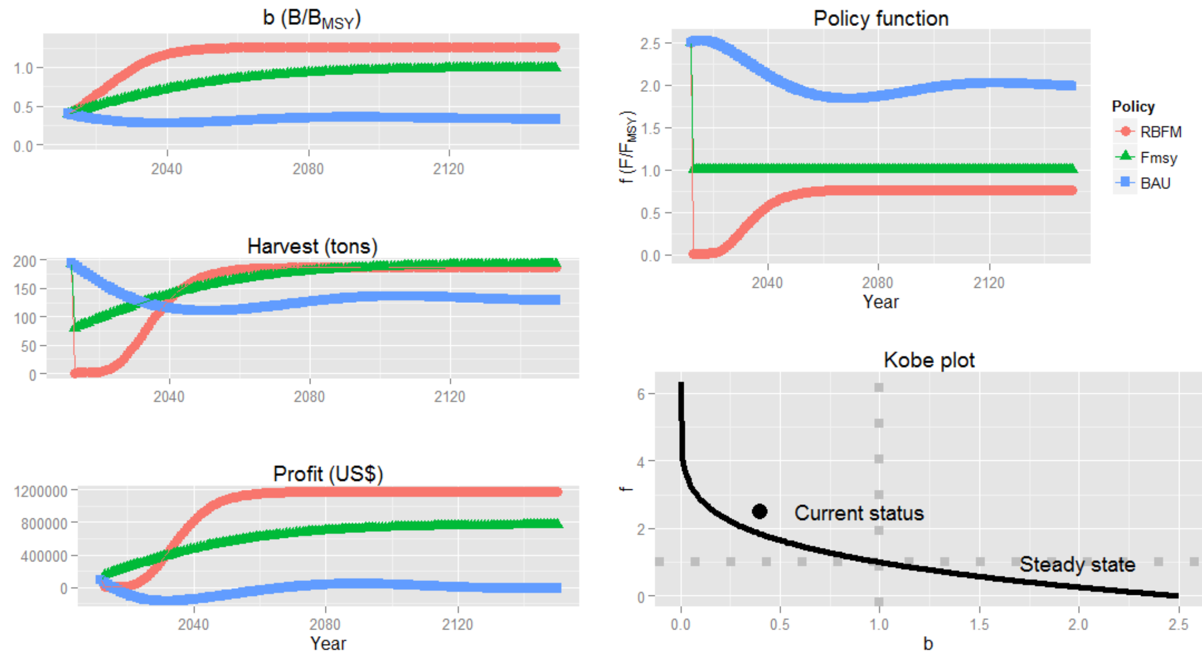

Figure S1: Illustration of a sample fishery projected forward from its current status (parameters in Table S1) under the different policy scenarios (1) Rights-Based Fishery Management (RBFM), (2) F_{MSY}, and (3) Business as Usual (BAU). The current status of the fishery together with the steady state solution of the fishery for various *b* and *f* combinations is shown in the Kobe plot. Under BAU, profit disappears and both biomass and harvest decline from current levels. The F_{MSY} policy would simultaneously increase the biomass and profit. The RBFM strategy suggests a near closure of the fishery initially before slowly increasing *f*. This strategy results in a large increase in profit. RBFM would also be good for conservation, as biomass would increase three-fold in 50 years.

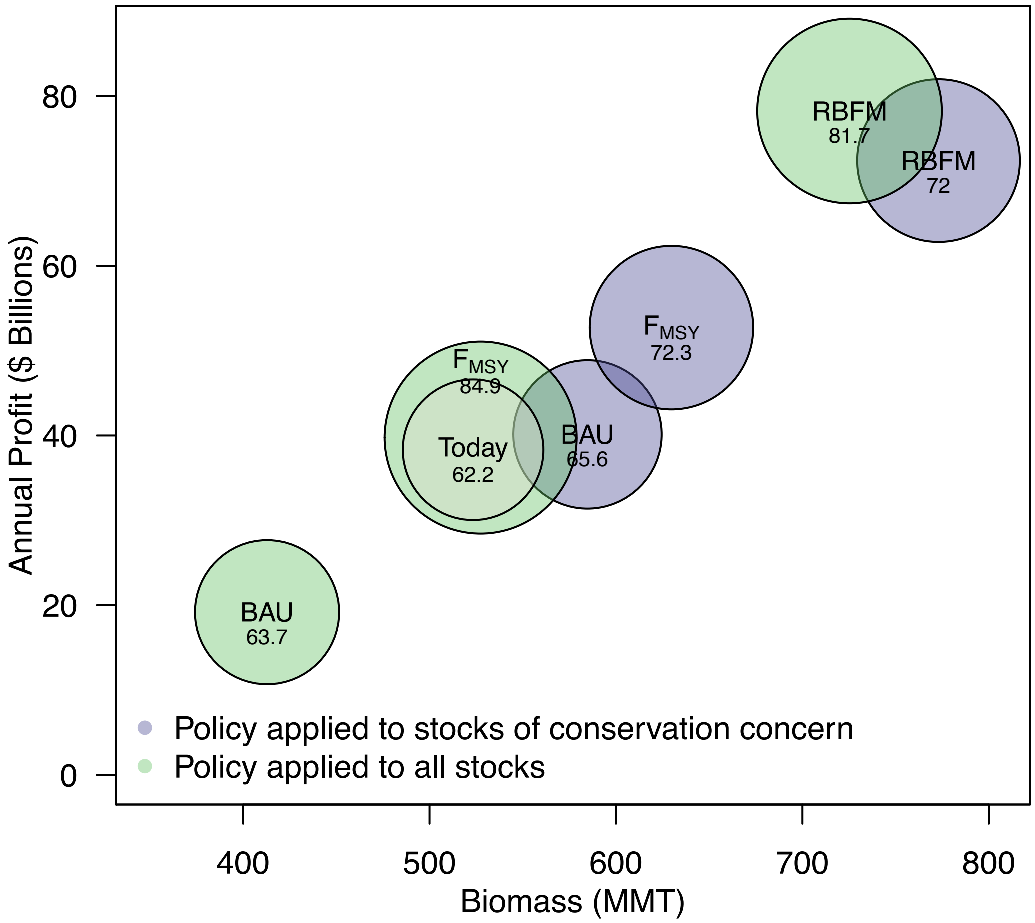

Figure S2. Alternative version of Figure 3 illustrating global results by policy when $\phi = 1$ and the biological model reproduces the Schaefer model, where B_{MSY} occurs at 50% of K. The primary effect of this scenario is to reduce the estimates of total biomass under all policies relative to results presented in the body of our paper. Note that fewer fisheries can be projected under this scenario.

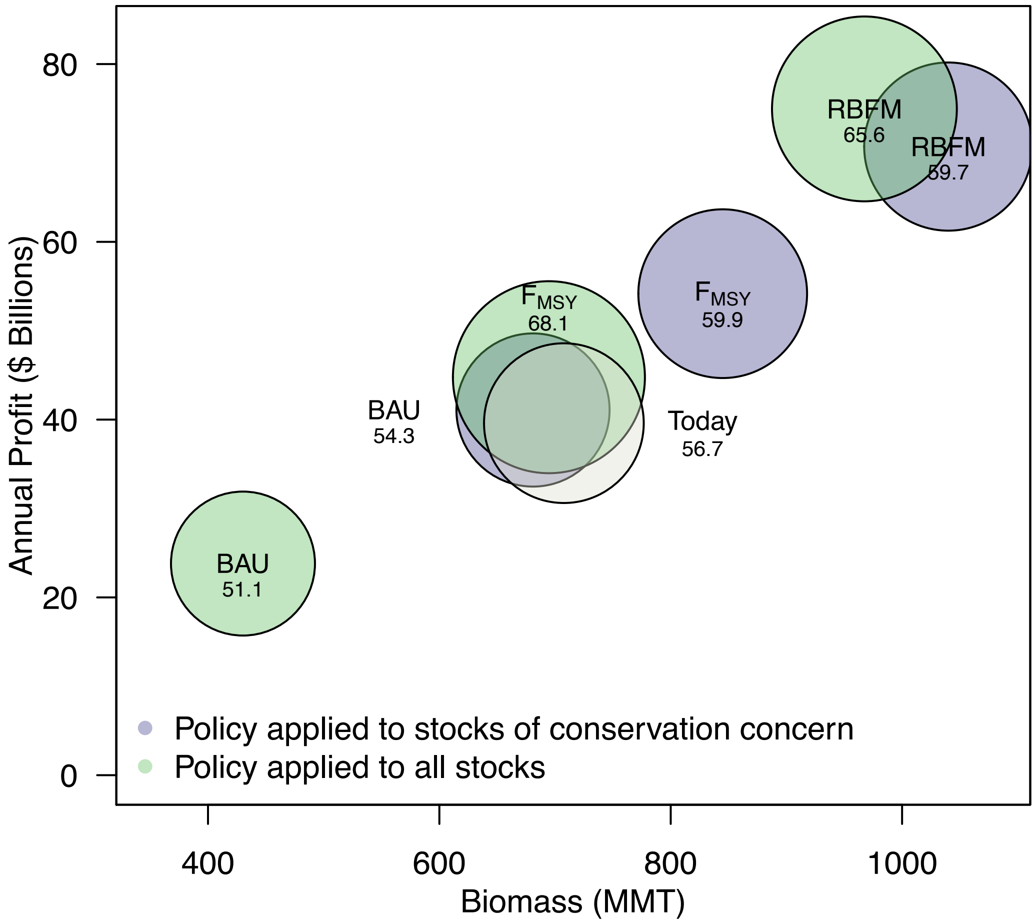

Figure S3. Alternative version of Figure 3 that adopts order-specific $\boldsymbol{\phi}$ values. Thorson *et al.* (2012) provide separate $\frac{\boldsymbol{B_{MSY}}}{\boldsymbol{K}}$ ratios for the orders Pleuronectiformes, Gadiformes, Perciformes, Clupeiformes, and Scorpaeniformes. For fisheries not included in the five taxonomic groups, we set $\boldsymbol{\phi = 0.188}$, such that B_{MSY} occurs at 40% of K, as per ref (9). This scenario has very little effect on our results relative to the results presented in the body of our paper, though it does reduce gross values do the inability of Catch-MSY to converge for some stocks.

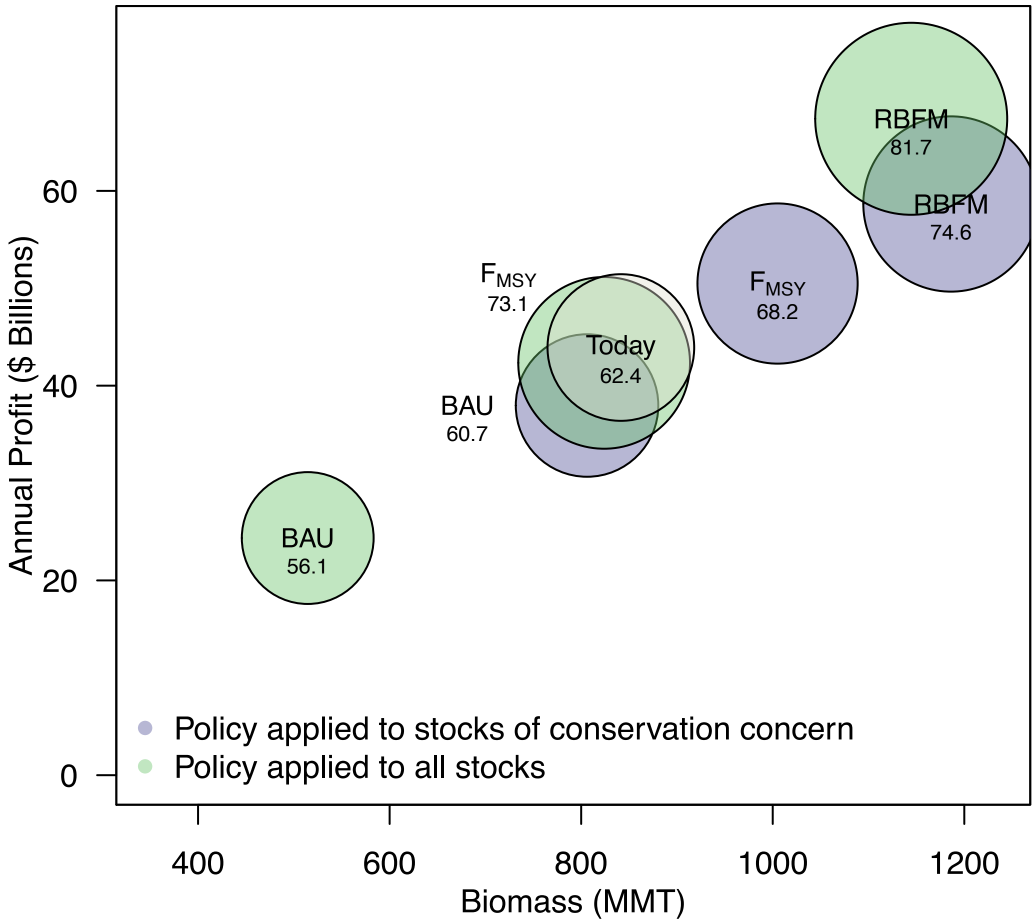

Figure S4. Alternative version of Figure 3 when $\beta = 1$, meaning that costs increase linearly in relation to fishing mortality. The primary result of this scenario is to reduce total biomass under the RBFM policies, as the decreased costs make increased levels of fishing more profitable relative to the results presented in the body of our paper.

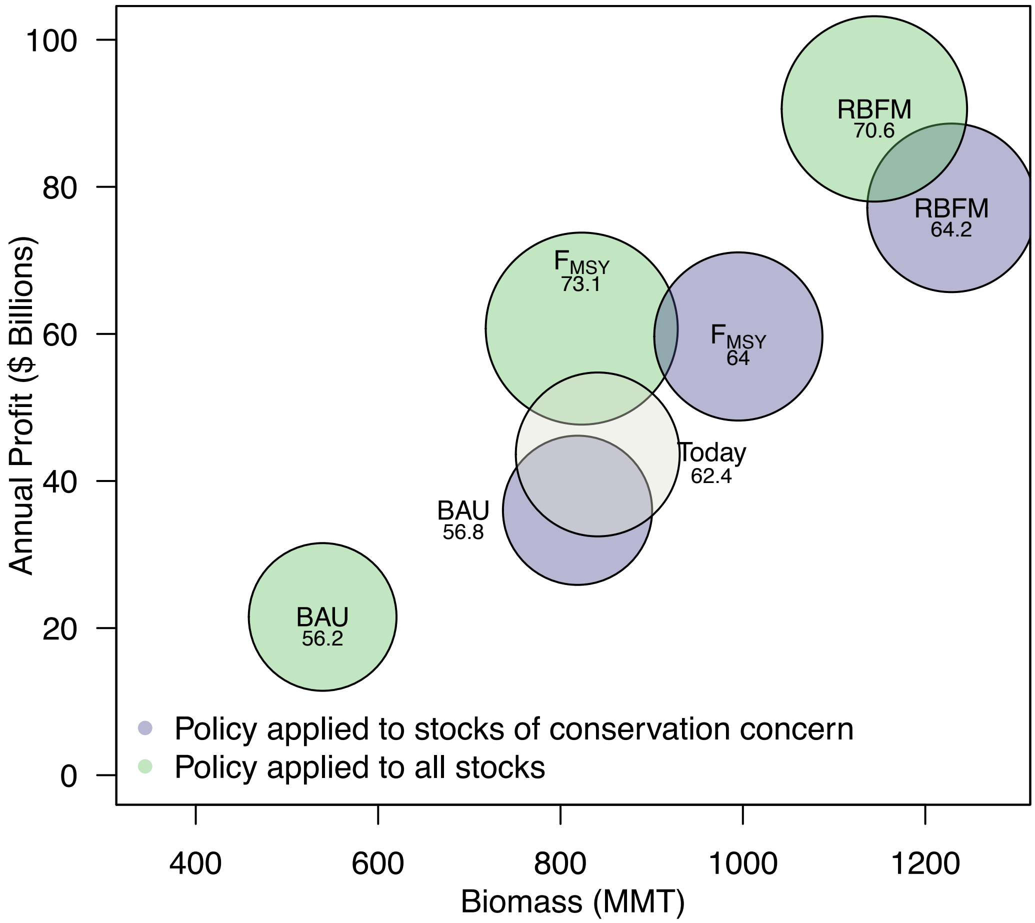

Figure S5. Alternative version of Figure 3 from the main manuscript when the demand function is perfectly elastic and prices are thus not adjusted as a function of global fish supply. The primary effect of omitting a downward sloping global demand curve is an increase in the profit differences between policies applied to conservation concern and policies applied to all stocks. This difference relative to the results presented in the body of our paper is due to the lack of compensatory effects between catches and prices.

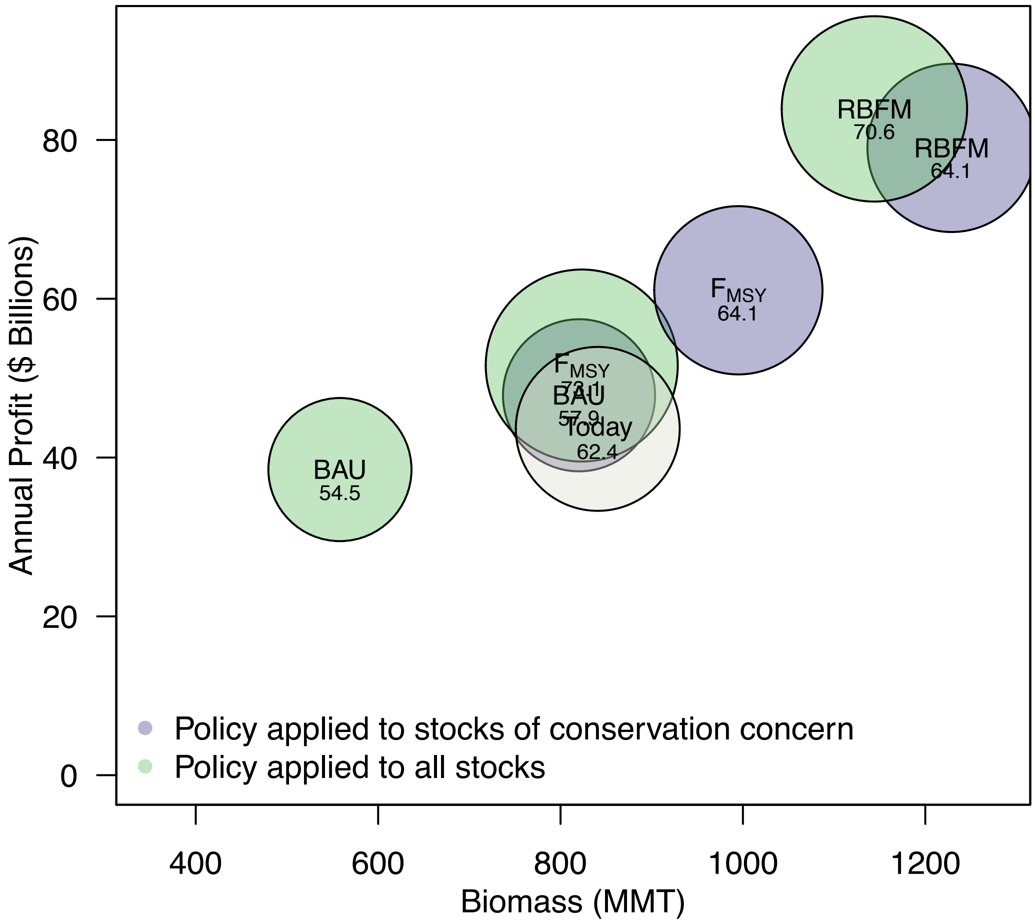

Figure S6. Alternative version of Figure 3 where the demand function has been modified to include distinct global markets for five fisheries commodities categories; Low-value finfish, High-value finfish, Crustaceans, Molluscs, and Other marine animals as per ref(13). Prices are adjusted according to Equations 10-12 where q_s is the global supply of fish in the commodity category *s* of fishery *i.* The primary effect is to increase profits under the BAU policy applied to all stocks relative to the results presented in the body of our paper.

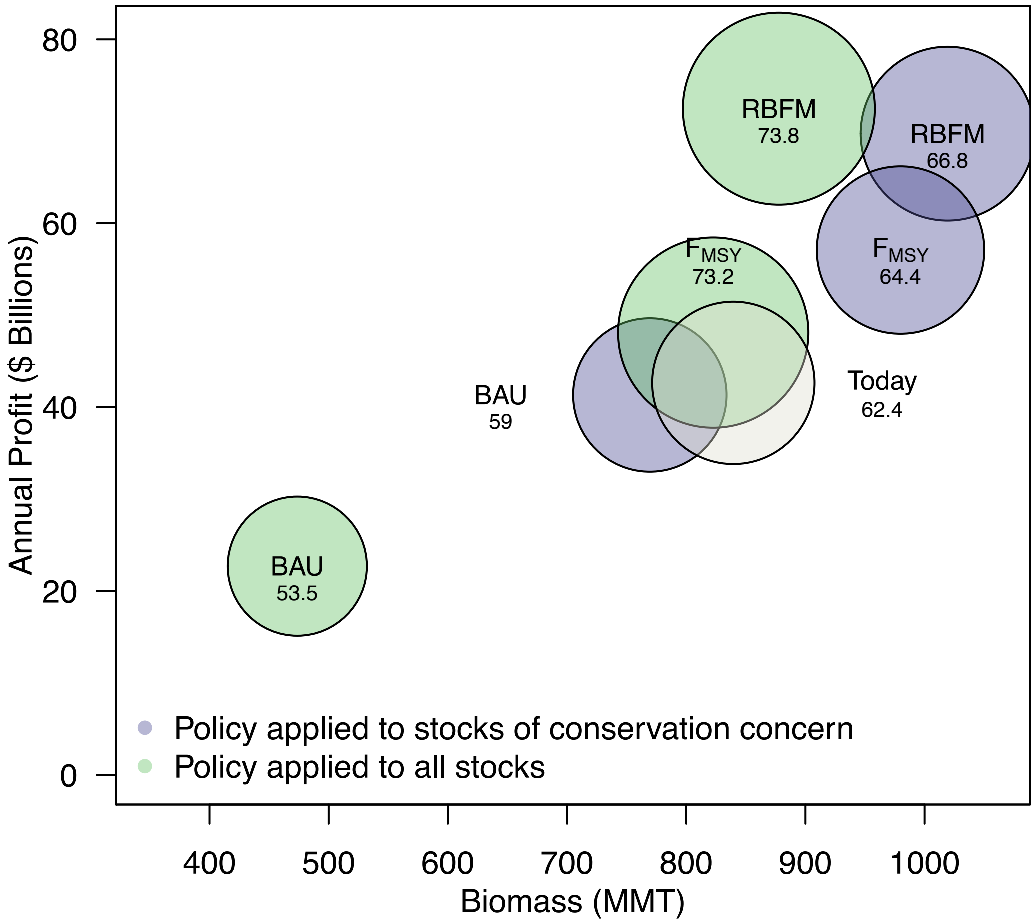

Figure S7. Alternative version of Figure 3 illustrating global results by policy when policies are optimized using a 5% discount rate. Non-discounted profits in 2050 are presented for comparison. The primary effect of this scenario is to decrease biomass in 2050 under the RBFM policies, relative to results presented in the body of our paper.

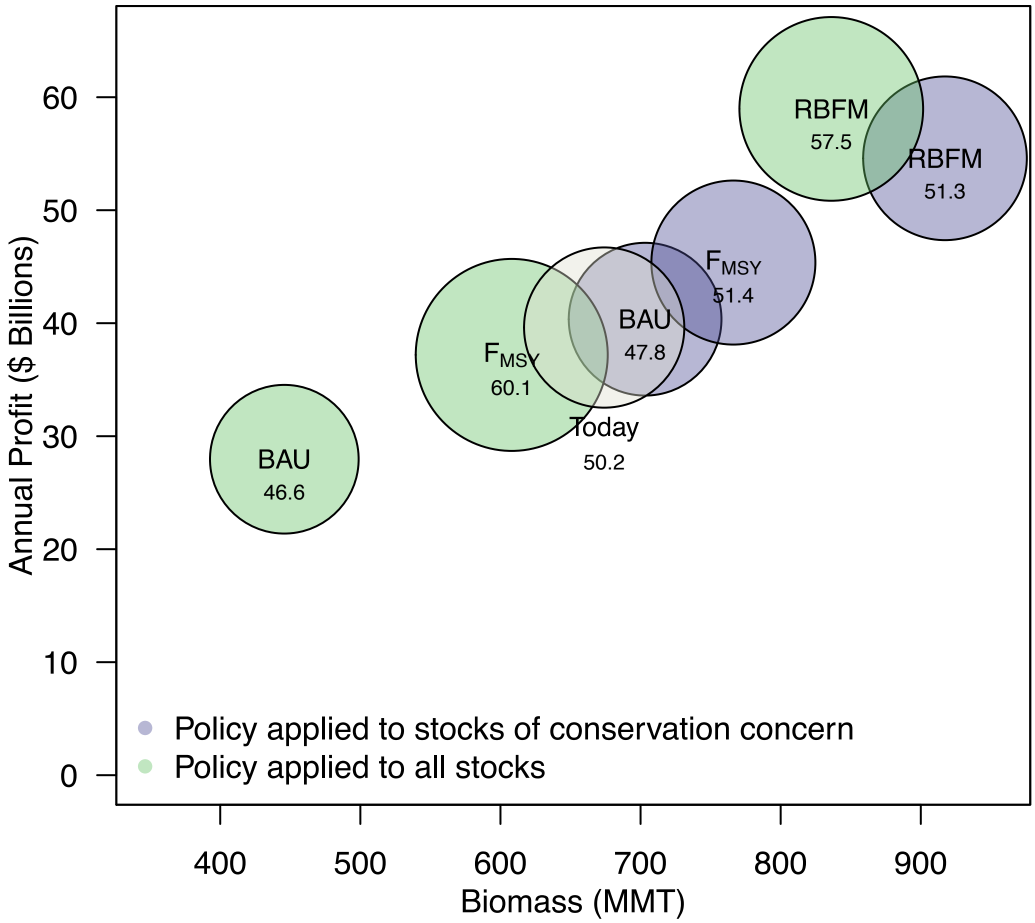

Figure S8. Alternative version of Figure 3 illustrating global results in 2050 by policy when NEI fisheries are omitted. The omission of the 1,932 NEI fisheries lowers our estimates of annual global profits, catch, and biomass for all policies, and increases the relative performance with respect to profits of the BAU policy applied to all stocks compared to results presented in the body of our paper.

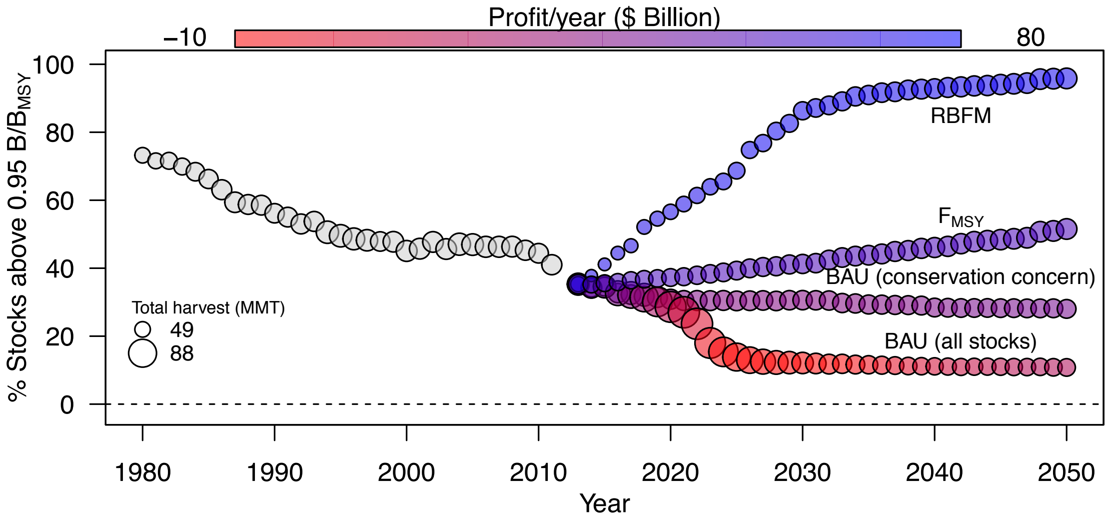

Figure S9. Alternative version of Figure 4 illustrating global results using a recovery threshold of B/B_{MSY} >= 0.95. The higher recovery target primarily influences the results of the F_{MSY} policy, lowering the proportion of stocks achieving recovery by 2050 from 85% to 52%. The outcomes of the RBFM and BAU policies are largely unaffected.

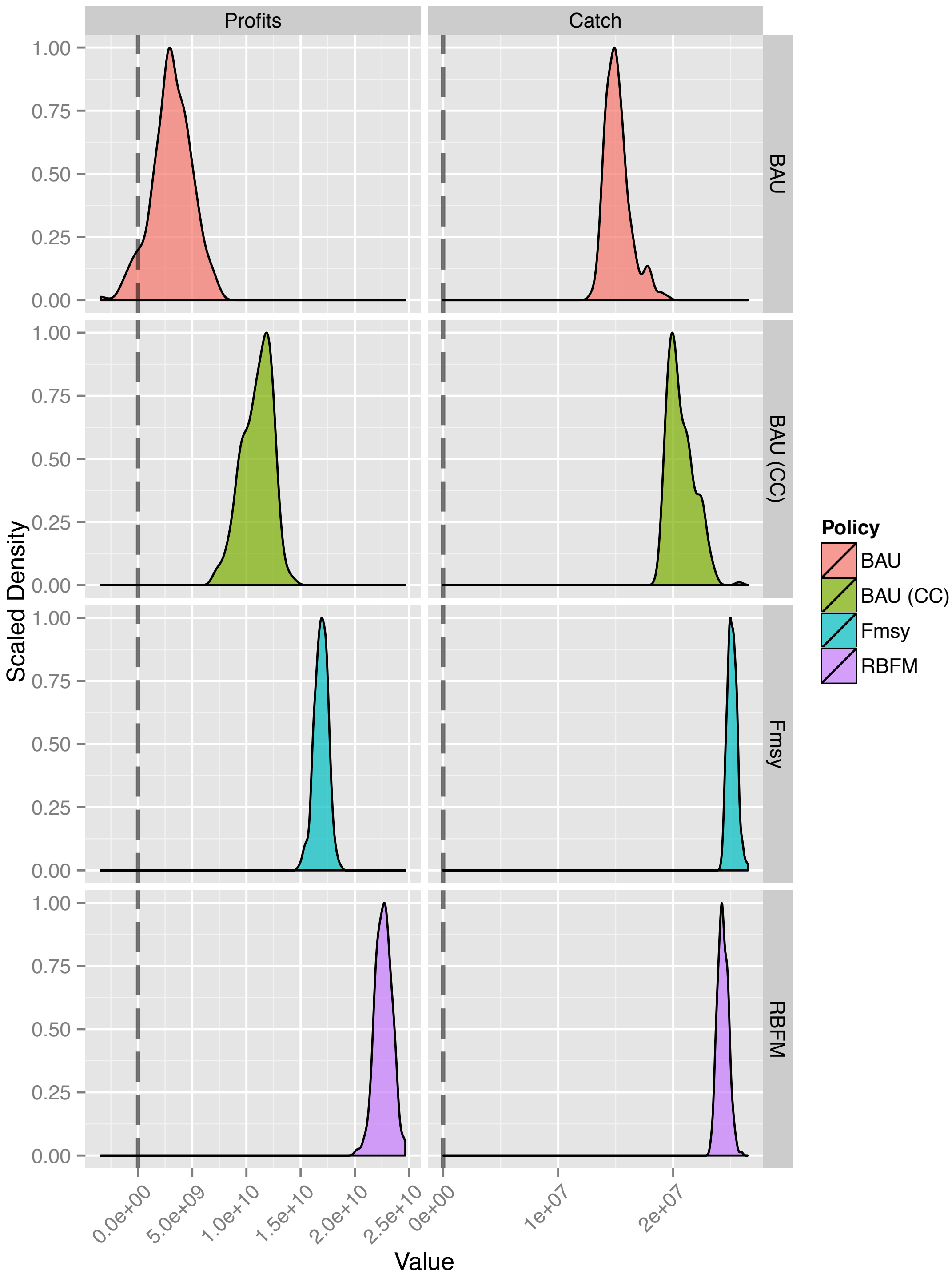

Figure S10. Distributions of total predicted catches and profits in 2050 for all stocks included in the Catch-MSY Monte Carlo. Results suggest that our estimates of total catch are relatively insensitive to uncertainty in price, costs, growth rates, and carrying capacity while our estimates of total profits are much more sensitive, particularly for the BAU policies.

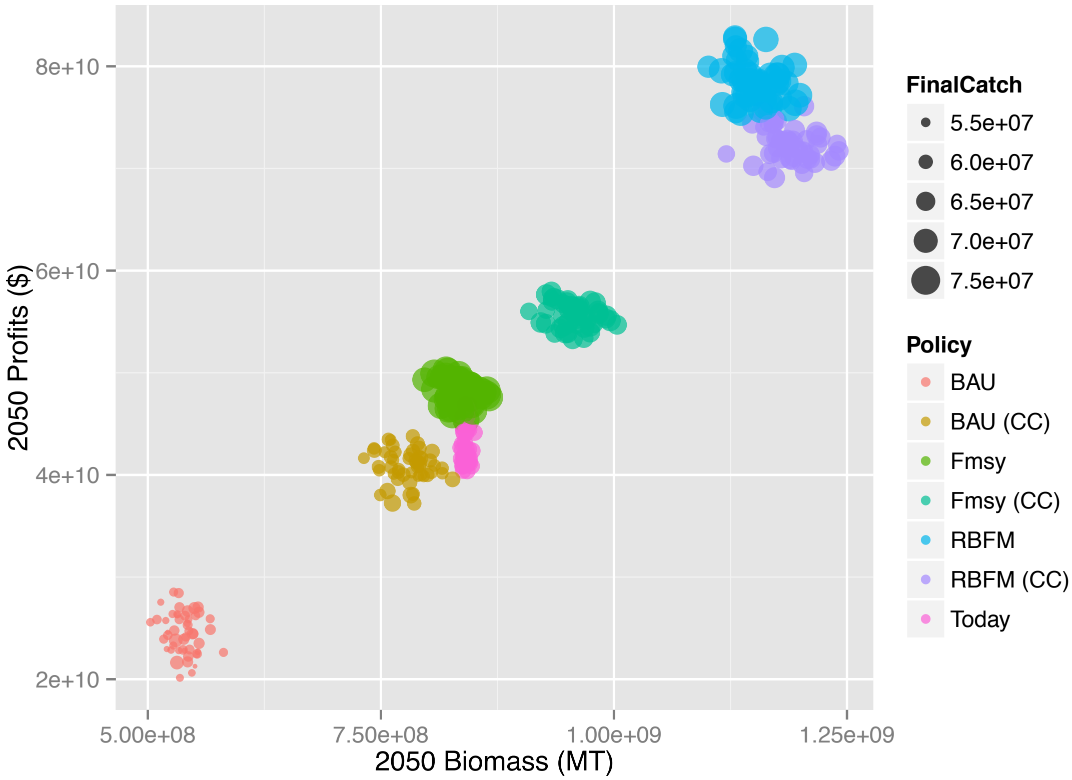

Figure S11. Expanded Monte Carlo analysis of Figure 3. The "CC" indicates policies applied only to stocks of conservation concern. Color indicates policy and circle size indicates total catch in 2050. Each points shares a draw from the same iteration of the Monte Carlo routine with a particular point in the other policies. As such, while it may appear for example that in some instances the RBFM (CC) policy produced higher profits than when applying RBFM to all stocks, each point was not truly independently estimated for each policy, and so this is not a reliable comparison. Rather, the cloud for any given policy provides an estimate of the uncertainty around that particular policy, but is not as informative as to the ranking of that policy relative to other policies.

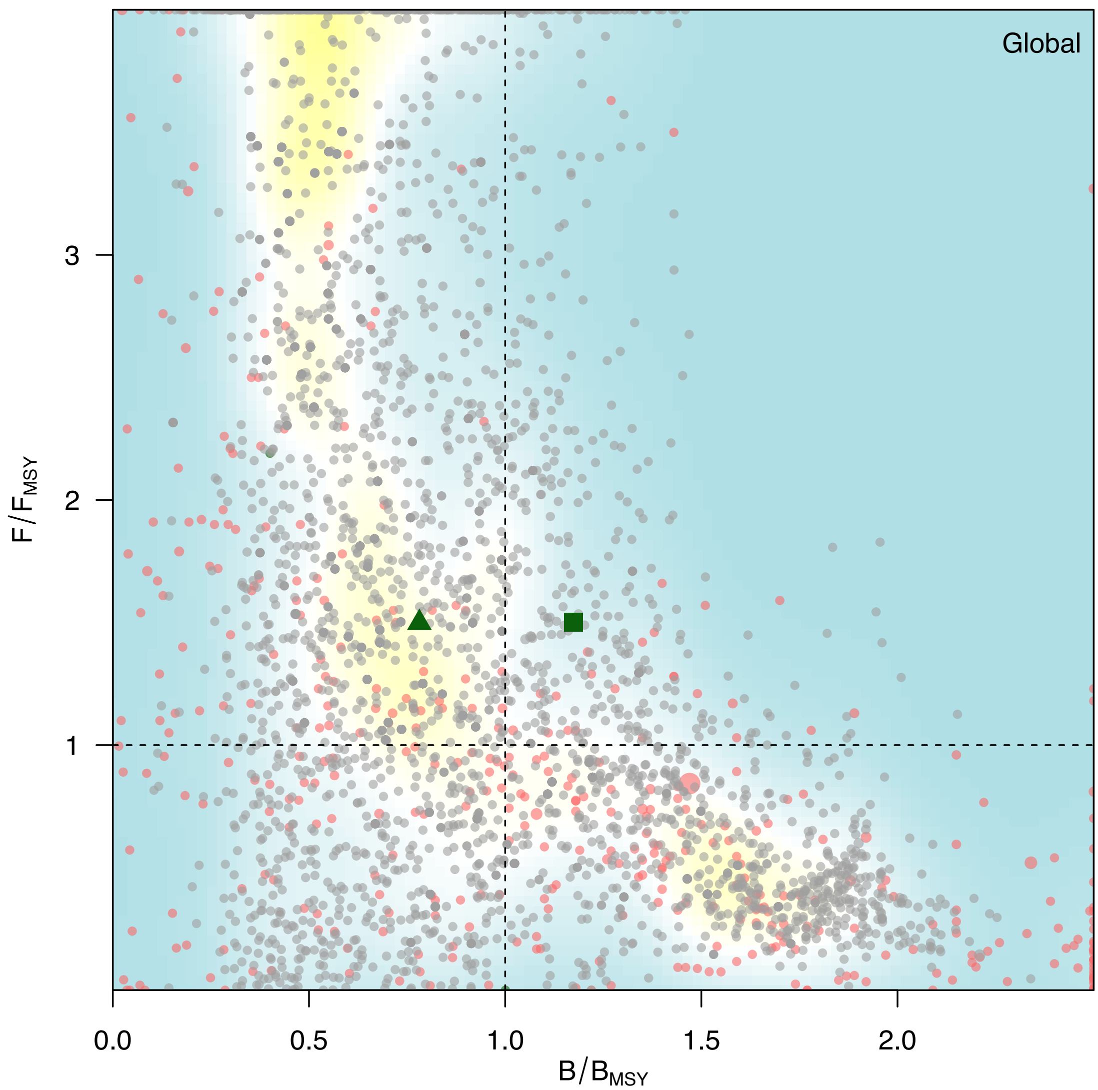

Figure S12. Global Kobe plot showing the status of all fisheries (n=4,713) in dataset. Dot color indicates the database of origin (RAM=red, FAO=black, SOFIA=green) and dot sizes are scaled proportional to catch. Shading represents the density of fisheries with similar current estimates of B/B_{MSY} and F/F_{MSY}, with shading following a color gradient from blue (low density) to gold (high density). The dark green triangle represents the median global fishery (0.78 B/B_{MSY} and 1.5 F/F_{MSY}). The dark green square represents the catch-weighted average global fishery (1.17 B/B_{MSY} and 1.5 F/F_{MSY}).

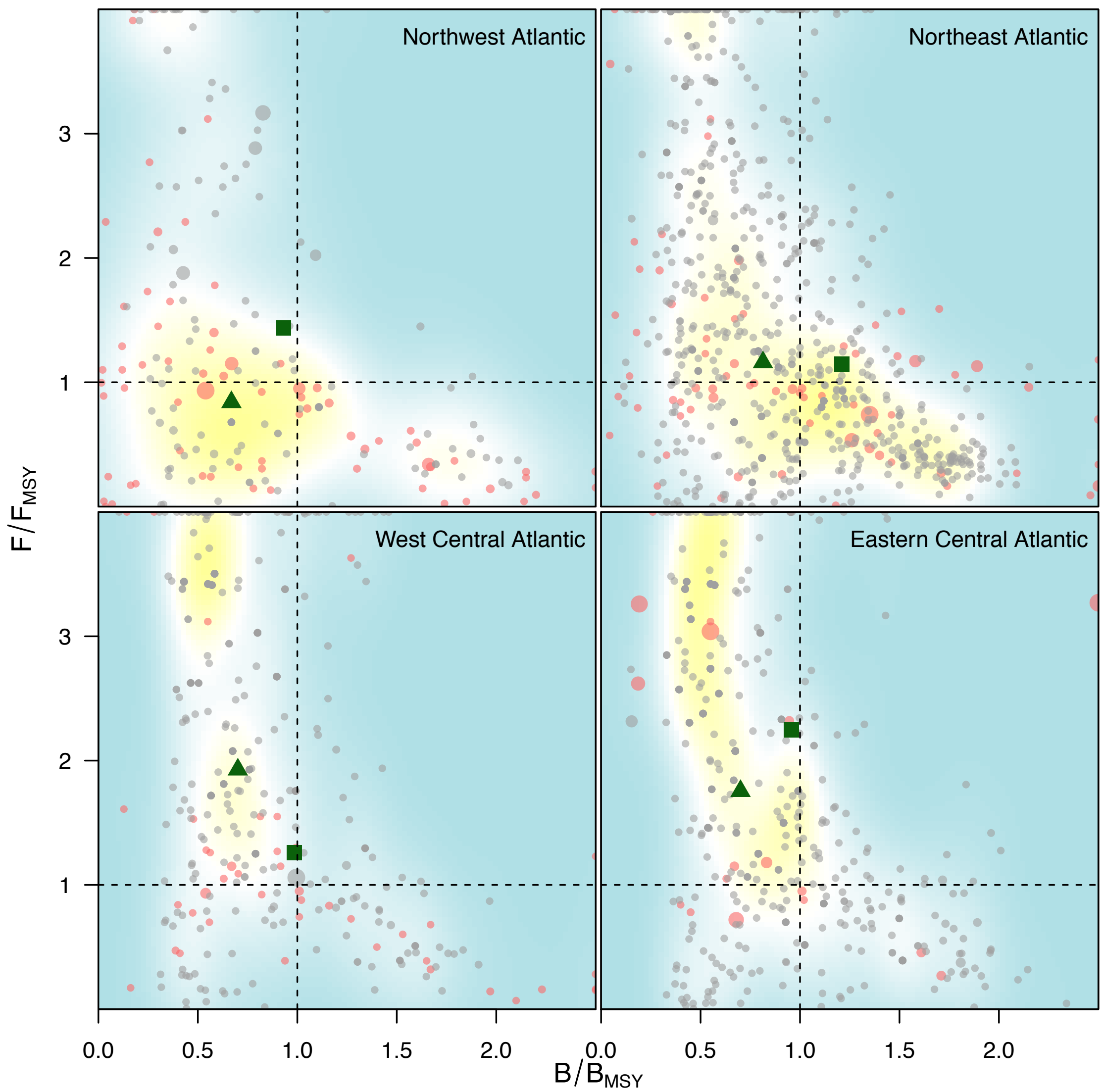

Figure S13. Kobe plots showing the status of fisheries in the Northwest, Northeast, West Central, and Eastern Central Atlantic Ocean FAO major fishing areas. Dot color indicates the database of origin (RAM=red, FAO=black, SOFIA=green) and dot sizes are scaled proportional to catch. Shading represents the density of fisheries with similar current estimates of B/B_{MSY} and F/F_{MSY}, with shading following a color gradient from blue (low density) to gold (high density). The dark green triangle represents the median fishery and the dark green square represents the catch-weighted average fishery.

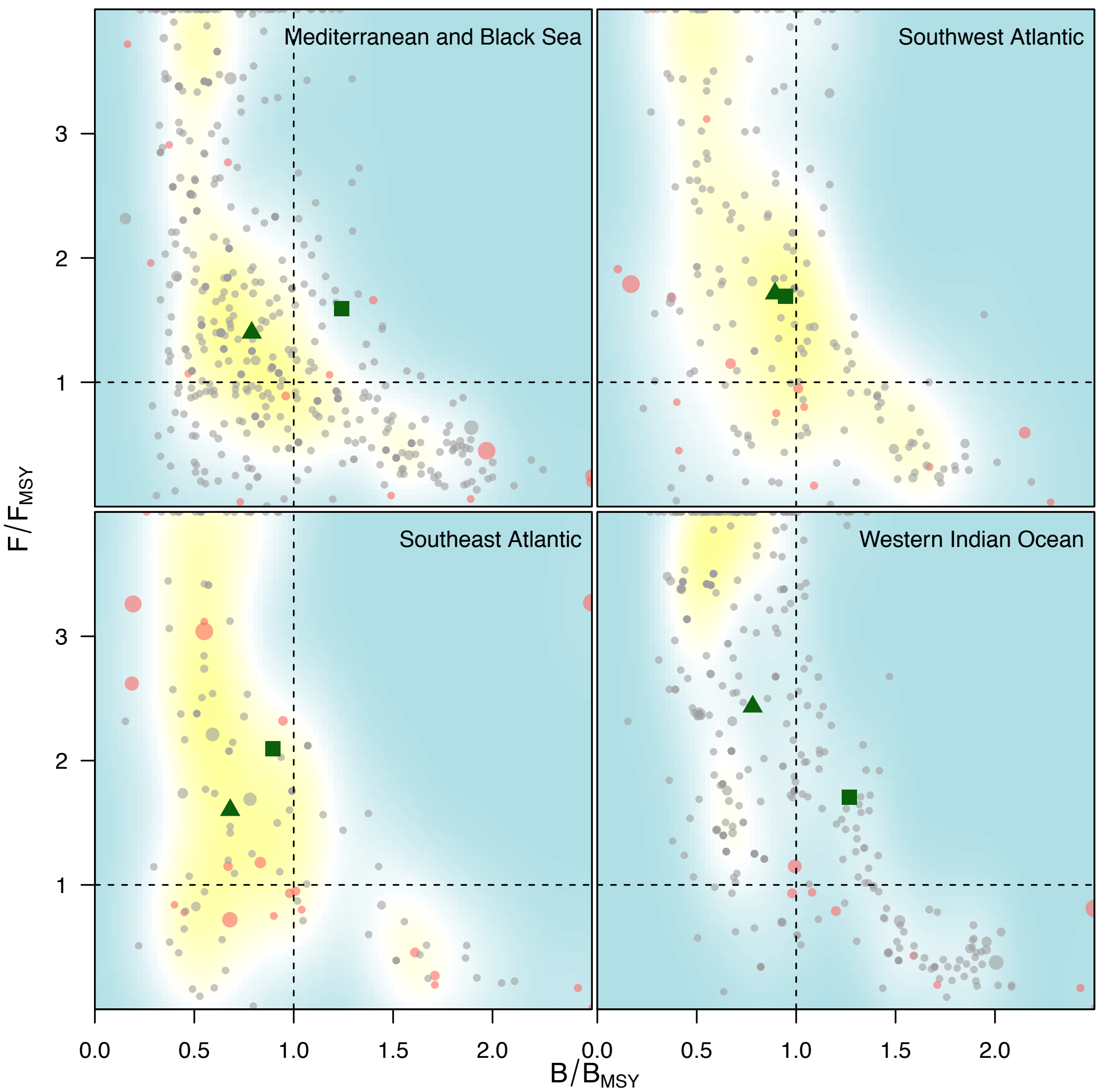

Figure S14. Kobe plots showing the status of fisheries in the Mediterranean and Black Sea, Southwest Atlantic, Southeast Atlantic, and Western Indian Ocean FAO major fishing areas. Dot color indicates the database of origin (RAM=red, FAO=black, SOFIA=green) and dot sizes are scaled proportional to catch. Shading represents the density of fisheries with similar current estimates of B/B_{MSY} and F/F_{MSY}, with shading following a color gradient from blue (low density) to gold (high density). The dark green triangle represents the median fishery and the dark green square represents the catch-weighted average fishery.

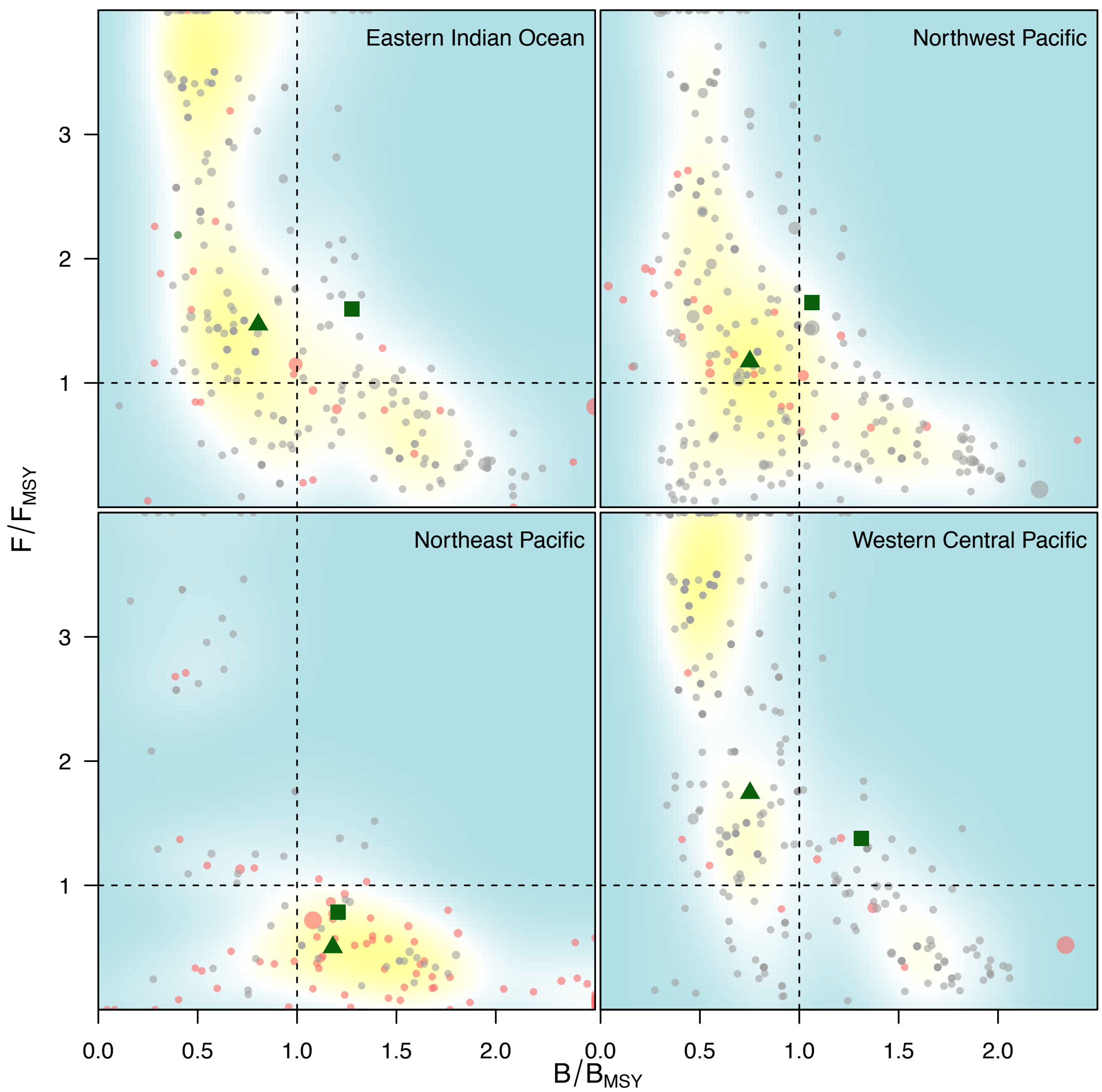

Figure S15. Kobe plots showing the status of fisheries in the Eastern Indian Ocean and the Northwest, Northeast, and Western Central Pacific Ocean FAO major fishing areas. Dot color indicates the database of origin (RAM=red, FAO=black, SOFIA=green) and dot sizes are scaled proportional to catch. Shading represents the density of fisheries with similar current estimates of B/B_{MSY} and F/F_{MSY}, with shading following a color gradient from blue (low density) to gold (high density). The dark green triangle represents the median fishery and the dark green square represents the catch-weighted average fishery.

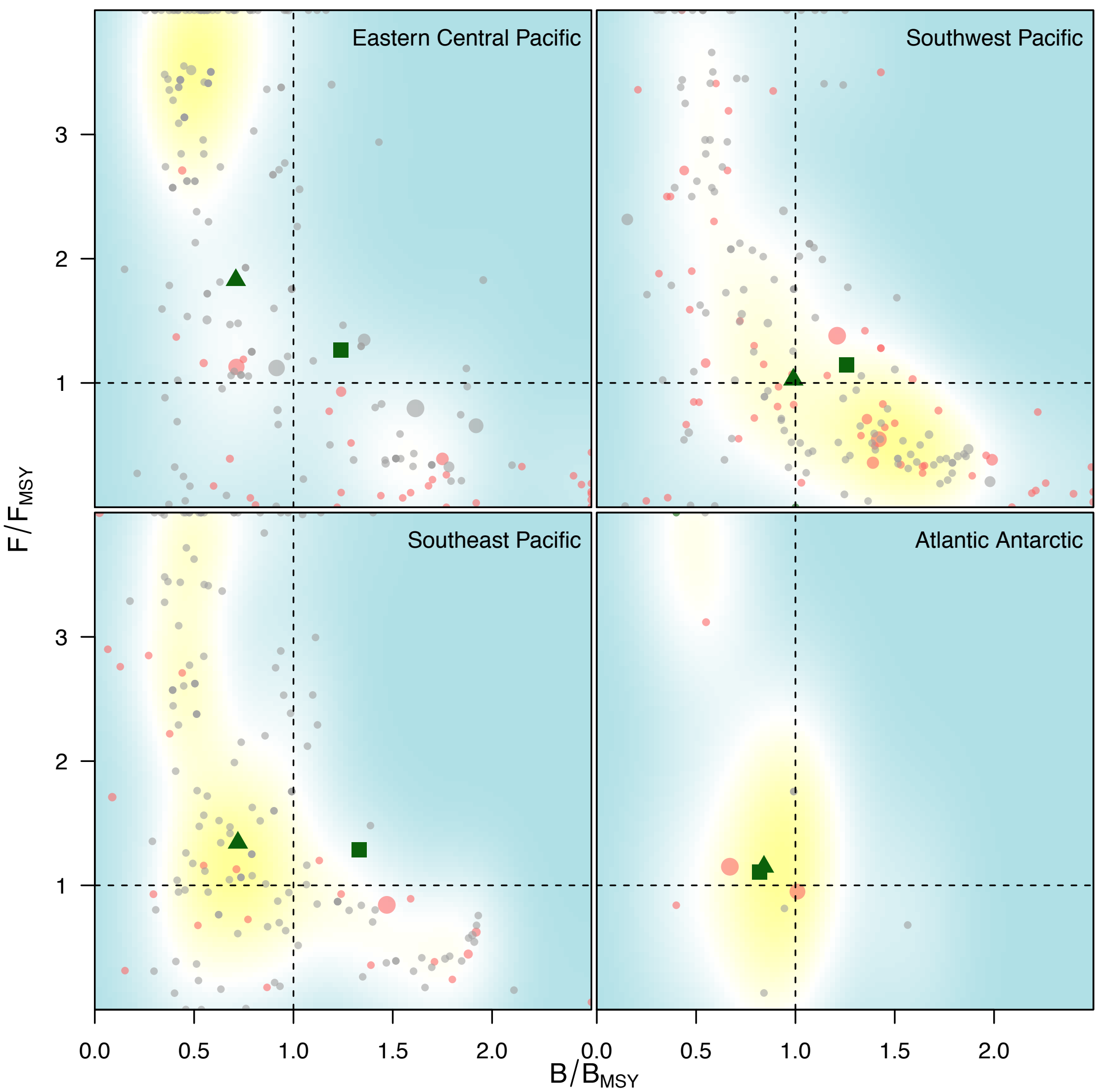

Figure S16. Kobe plots showing the status of fisheries in the Eastern Central, Southwest, and Southeast Pacific, as well as Atlantic Antarctic FAO major fishing areas. Dot color indicates the database of origin (RAM=red, FAO=black, SOFIA=green) and dot sizes are scaled proportional to catch. Shading represents the density of fisheries with similar current estimates of B/B_{MSY} and F/F_{MSY}, with shading following a color gradient from blue (low density) to gold (high density). The dark green triangle represents the median fishery and the dark green square represents the catch-weighted average fishery.

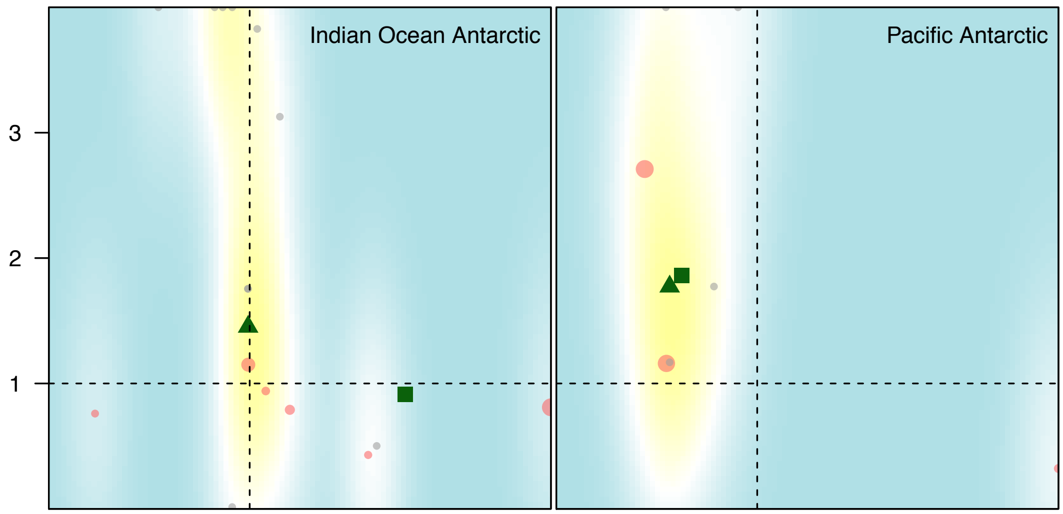

Figure S17. Kobe plots showing the status of fisheries in the Indian Ocean Antarctic and Pacific Antarctic FAO major fishing areas. Dot color indicates the database of origin (RAM=red, FAO=black, SOFIA=green) and dot sizes are scaled proportional to catch. Shading represents the density of fisheries with similar current estimates of B/B_{MSY} and F/F_{MSY}, with shading following a color gradient from blue (low density) to gold (high density). The dark green triangle represents the median fishery and the dark green square represents the catch-weighted average fishery.

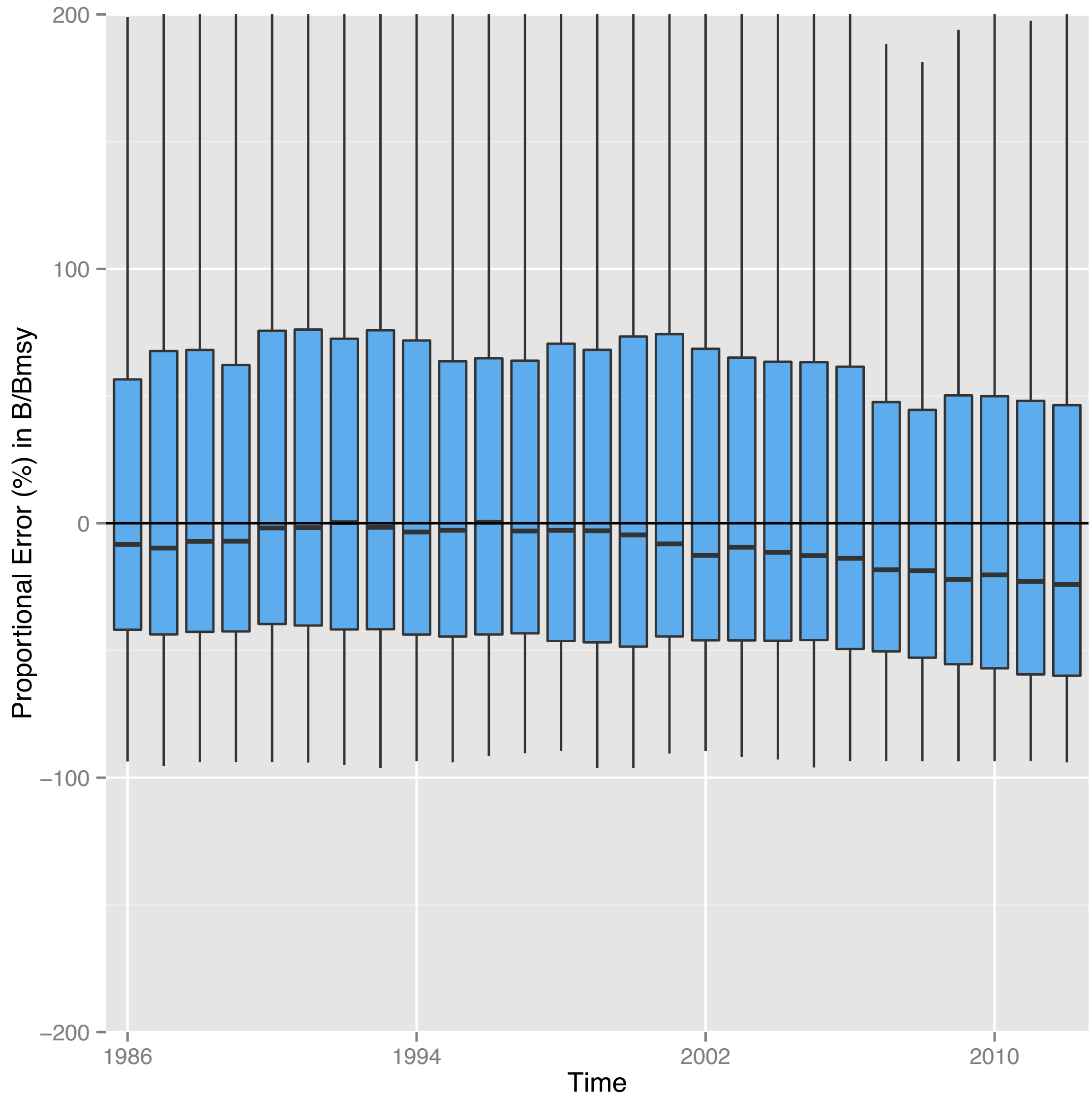

Figure S18. Distribution of proportional error ((predicted – true)/true) in predicted B/B_{MSY} for individual RAM fisheries over time resulting from individual jackknife.

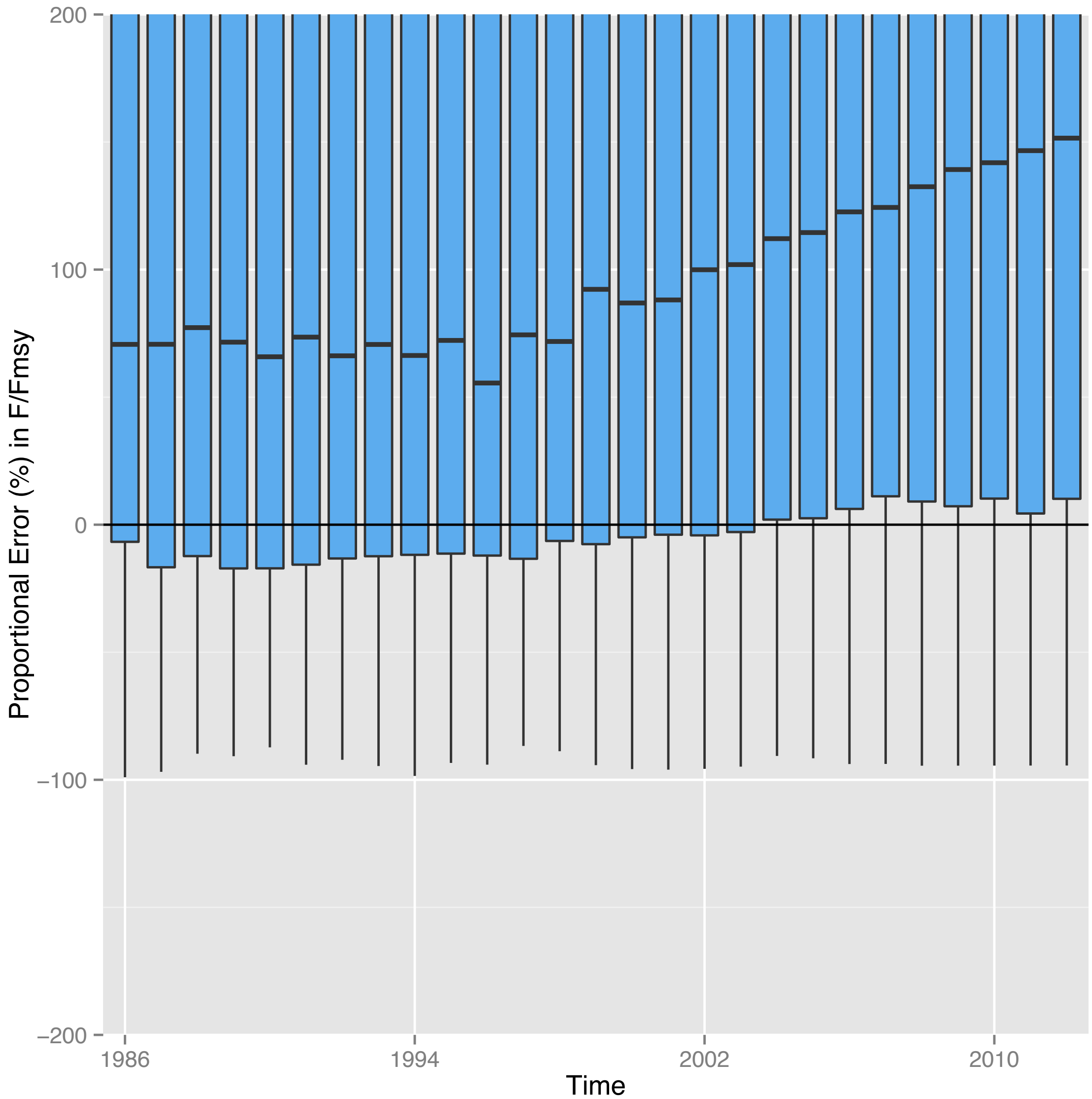

Figure S19. Distribution of proportional error ((predicted – true)/true) in predicted F/F_{MSY} of individual RAM fisheries over time resulting from individual jackknife.

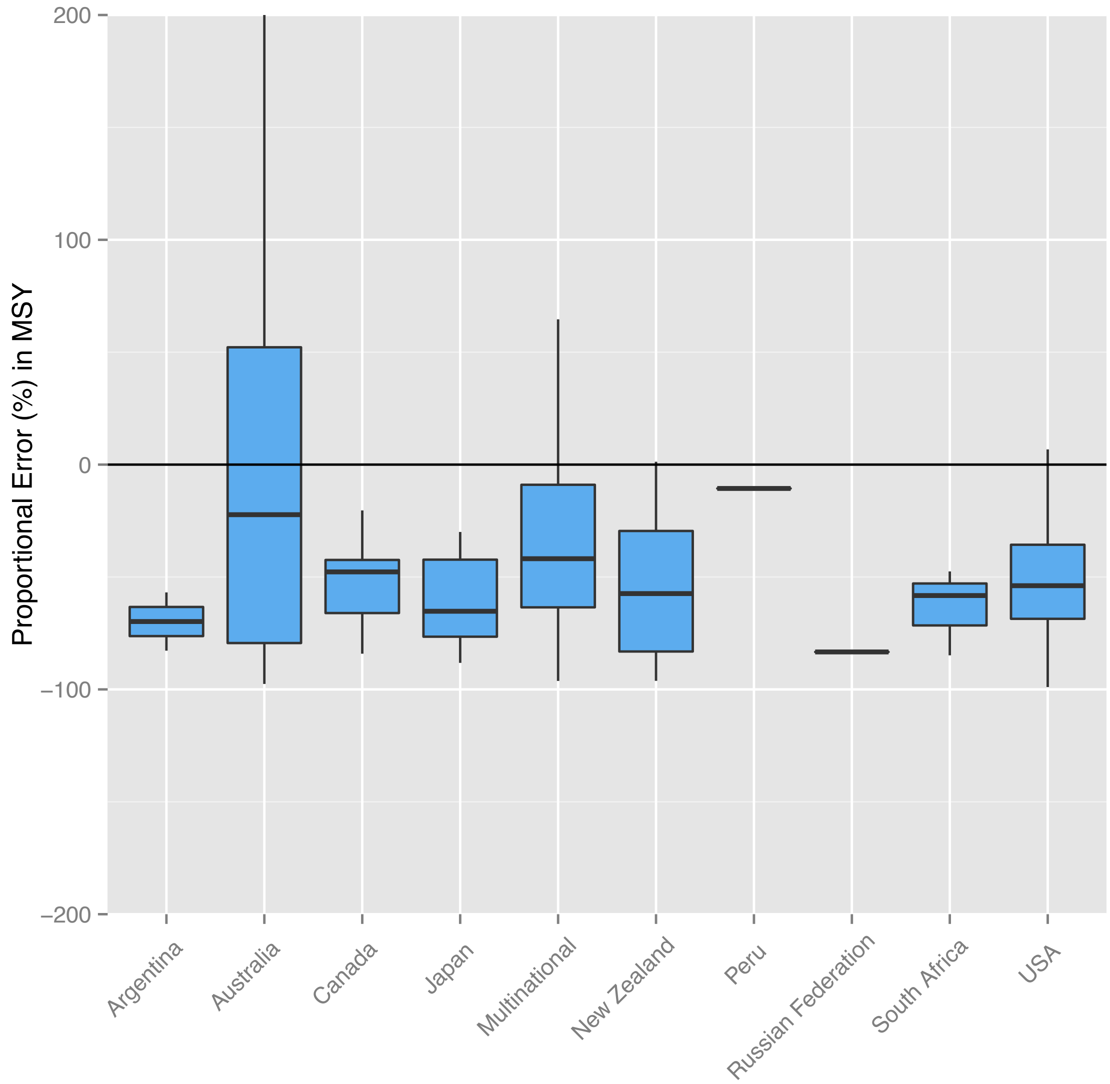

Figure S20. Distribution of proportional error ((predicted – true)/true) in predicted *MSY* of individual RAM fisheries by region resulting from regional jackknifing.

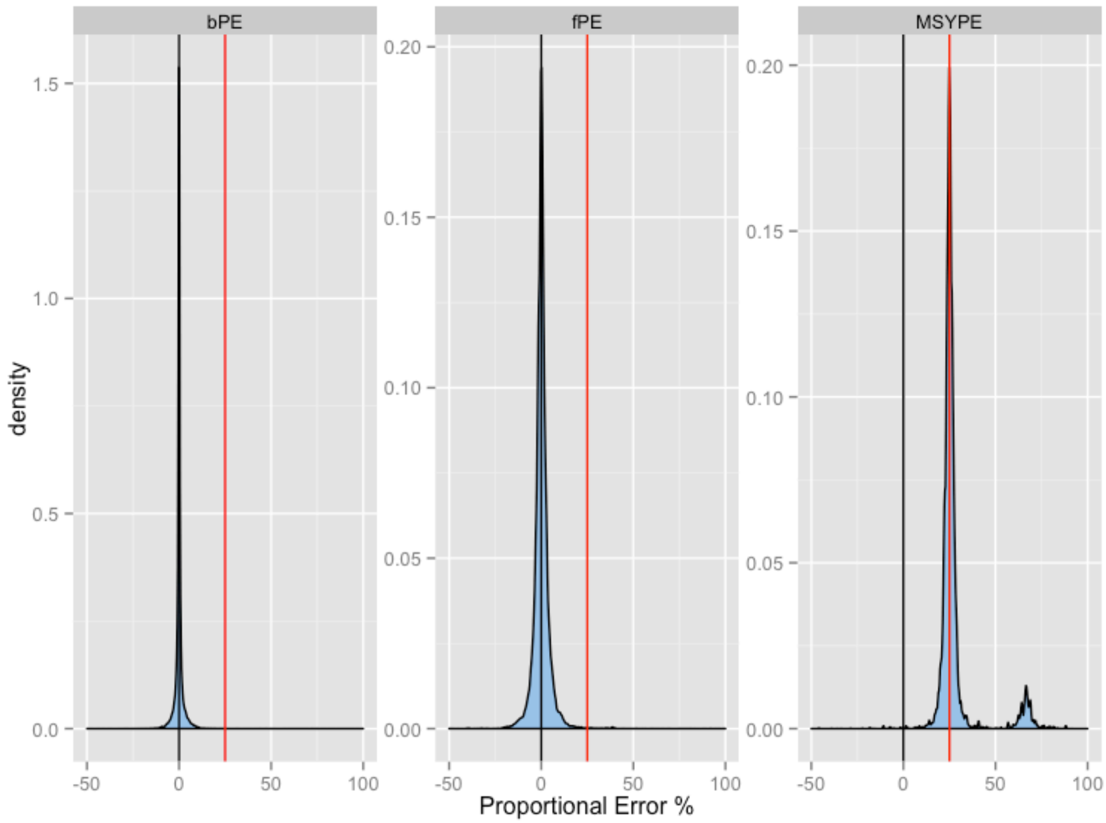

Figure S21. Effects of IUU. Catches are increased by 25% to simulate a scenario in which IUU is manifested as unreported catches. Proportional error (PE) ((predicted – true)/true) represents the % change from the current "true" estimates of B/B_{MSY} (bPE), F/F_{MSY} (fPE), and *MSY* (MSYPE). The black vertical line marks a proportional error of zero. The red line is the percentage of IUU used.

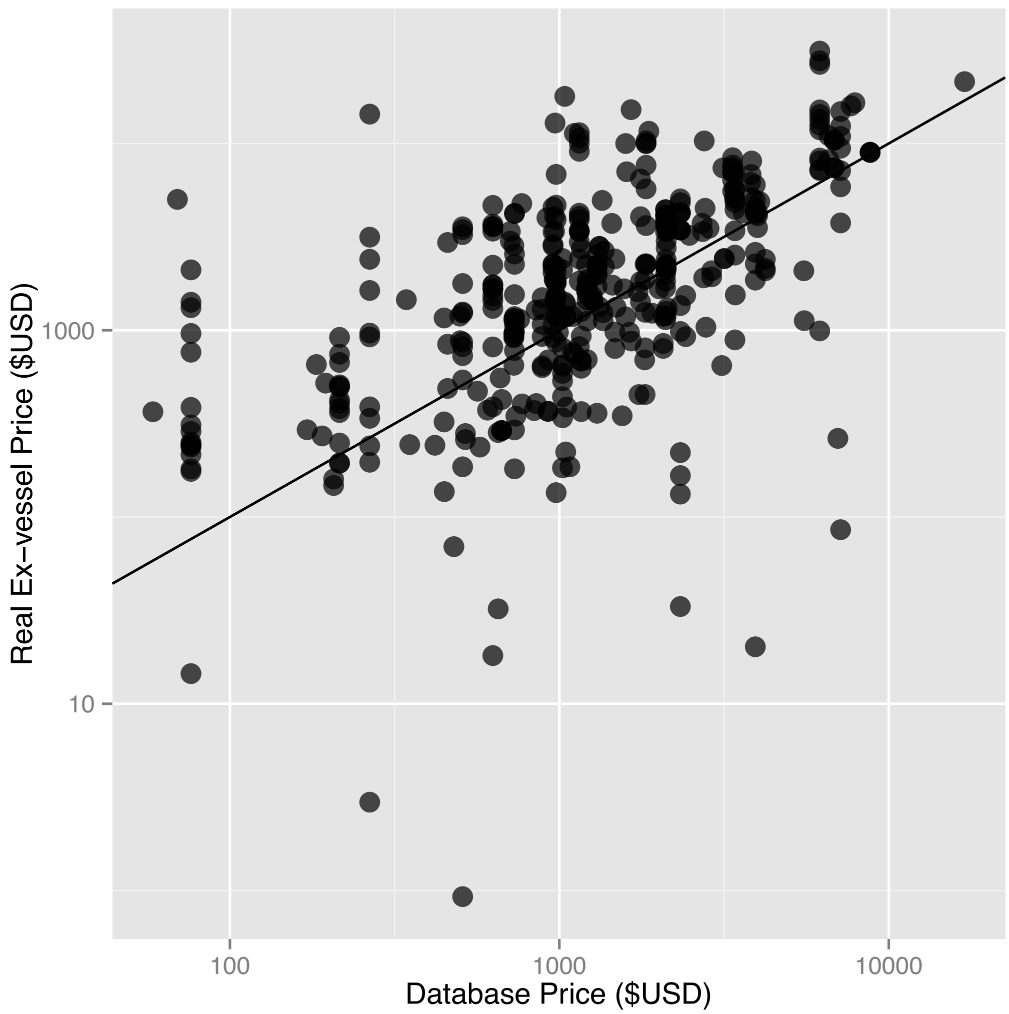

Figure S22. Comparison of ex-vessel prices used in the analysis to 421 ex-vessel prices for the same species obtained from fisheries agencies in the USA, Canada, New Zealand, and the EU. Data points represent 5-year average prices. The Pearson correlation coefficient for the relationship is 0.56.

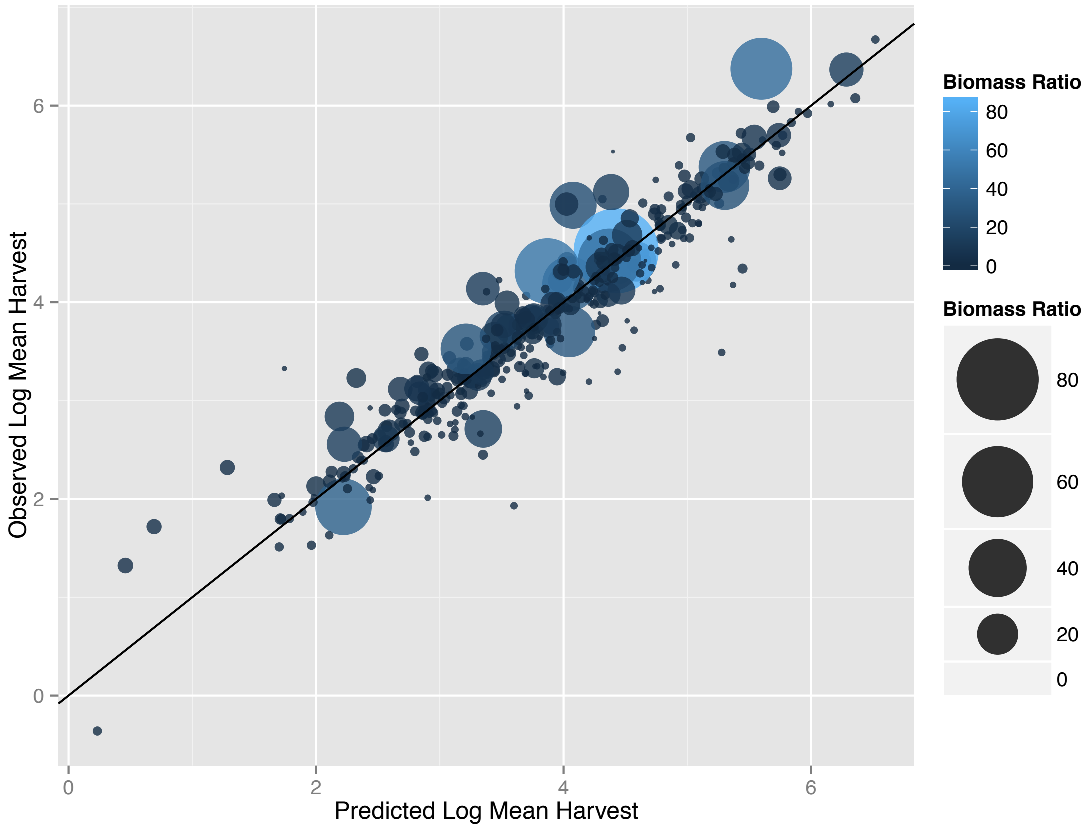

Figure S23. Model validation using historical data from the RAM database. The bioeconomic model was used to "project" annual harvests for the 397 RAM stocks used in the analysis. Data (B/B_{MSY}, F/F_{MSY}) from 1980 (or the earliest available year) served as the initial conditions for the analysis. Results compare the predicted log mean harvest over the time period against the observed log mean harvest over the same time period for each fishery. Dot size and color both represent the ratio of final B/B_{MSY} predicted by the model relative to the B/B_{MSY} in the RAM database. The Pearson correlation coefficient for the log-transformed relationship is 0.942 (0.887 for the untransformed data).

Supplementary Tables

Table S1. Parameters of a sample fishery used for the example policy projections in Figure S1

Variable	Value	Units	Description
∅	0.188	--	Scaling parameter (PT model)
g	0.038	--	Growth parameter (PT model)
b_{MSY}	0.4	--	Current estimated stock biomass relative to B_{MSY}
f_{MSY}	2.5	--	Current estimated total fishing mortality relative to F_{MSY}
MSY	194	Metric tons	Maximum sustainable yield
c	22,090,307	USD/unit fishing mortality	Variable fishing cost per unit of fishing mortality
p	5,438	USD/metric ton	Ex-vessel price
disc	0	--	Discount rate
λ	0.10	--	Dependency of entry-exit dynamics to profit under open access
β	1.3	--	Non-linear fishing cost constant

Table S2. Fisheries included from the RAM Legacy Stock Assessment Database. Benefits for fisheries listed as "Multinational" were distributed to countries identified as participating in that fishery using FAO landings data.

Stock Name	**Assigned Country**	**FAO Region**
Argentine anchoita Northern Argentina	Argentina	41
Argentine anchoita Southern Argentina	Argentina	41
Argentine hake Northern Argentina	Argentina	41
Argentine hake Southern Argentina	Argentina	41
Patagonian grenadier Southern Argentina	Argentina	41
Southern blue whiting Southern Argentina	Argentina	41
Blue Grenadier Southeast Australia	Australia	57,81
Bight redfish Southeast Australia	Australia	57,81
Deepwater flathead Southeast Australia	Australia	57,81
common gemfish Southeast Australia	Australia	57,81
Jackass morwong Southeast Australia	Australia	57,81
New Zealand ling Eastern half of Southeast Australia	Australia	57,81
New Zealand ling Western half of Southeast Australia	Australia	57
Orange roughy Cascade Plateau	Australia	57
Orange roughy Southeast Australia	Australia	57,81
Patagonian toothfish Macquarie Island	Australia	81
Silverfish Southeast Australia	Australia	57,81
School whiting Southeast Australia	Australia	57,81
Tiger flathead Southeast Australia	Australia	57,81
Blue Warehou Eastern half of Southeast Australia	Australia	57,81
Blue Warehou Western half of Southeast Australia	Australia	57
Sea Mullet Queensland and New South Wales	Australia	71,81
Rock Lobster South Australia Northern Zone	Australia	57,81
Rock Lobster South Australia Southern Zone	Australia	57,81
Snapper Northern Spencer Gulf	Australia	57
Snapper Southern Gulf St. Vincent	Australia	57
Snapper Southern Spencer Gulf	Australia	57
Tasmanian giant crab Tasmania	Australia	57
Canary rockfish West Coast of Vancouver Island and Straight of Georgia and Queen Charlotte Islands	Canada	67
Atlantic cod NAFO 4VsW	Canada	21
Atlantic cod NAFO 4X	Canada	21
Haddock NAFO-4X5Y	Canada	21
Atlantic cod NAFO 2J3KL	Canada	21

Atlantic cod NAFO 3Ps	Canada	21
Monkfish Labrador Shelf - Grand Banks - St. Pierre Bank	Canada	21
Sea scallop Georges Bank	Canada	21
Snow Crab Division 2J	Canada	21
Snow Crab Division 3K	Canada	21
Snow Crab Division 3NO	Canada	21
Snow Crab Division 3Ps	Canada	21
English sole Hecate Strait	Canada	67
Pacific herring Central Coast	Canada	67
Pacific herring Queen Charlotte Islands	Canada	67
Pacific herring Straight of Georgia	Canada	67
Pacific herring West Coast of Vancouver Island	Canada	67
Pacific cod Hecate Strait	Canada	67
Pacific cod West Coast of Vancouver Island	Canada	67
Rock sole Hecate Strait	Canada	67
Sablefish Pacific Coast of Canada	Canada	67
Pollock NAFO-4VWX5	Canada	21
Atlantic cod NAFO 3Pn4RS	Canada	21
Atlantic cod NAFO 4TVn	Canada	21
Snow crab Southern Gulf of St. Lawrence	Canada	21
Alaskan Pollock Pacific Coast of Japan	Japan	61
Blue mackerel East China Sea	Japan	61
Blue mackerel Pacific Coast of Japan	Japan	61
Yellow sea bream Sea of Japan	Japan	61
Chub mackerel Pacific Coast of Japan	Japan	61
Chub mackerel Tsushima Strait	Japan	61
Japanese anchovy Pacific Coast of Japan	Japan	61
Japanese anchovy Inland Sea of Japan	Japan	61
Japanese anchovy Tsushima Strait	Japan	61
Jack mackerel Pacific Coast of Japan	Japan	61
Japanese jack mackerel Tsushima Strait	Japan	61
Olive flounder Pacific Ocean	Japan	61
flounder Inland Sea of Japan	Japan	61
Red seabream East China Sea	Japan	61
Red seabream Inland Sea of Japan (East)	Japan	61
Red seabream Inland Sea of Japan (West)	Japan	61
Round herring Tsushima Strait	Japan	61
Japanese Spanish mackerel Inland Sea of Japan	Japan	61

Atlantic cod Northeast Arctic	Multinational	27
Greenland halibut Northeast Arctic	Multinational	27
Golden Redfish Northeast Arctic	Multinational	27
Haddock Northeast Arctic	Multinational	27
Pollock Northeast Arctic	Multinational	27
Antarctic toothfish Ross Sea	Multinational	88
Southern bluefin tuna Southern Oceans	Multinational	58,51,57,41,47,81,71,87
Anchovy South of Sicily	Multinational	37
Sardine South of Sicily	Multinational	37
Whiting Black Sea	Multinational	37
Anchovy West Africa	Multinational	34,47
Cunene Horse Mackerel West Africa	Multinational	34,47
Chub Mackerel West Africa	Multinational	34,47
Horse Mackerel West Africa	Multinational	34,47
Round Sardinella West Africa	Multinational	34,47
Sardinella West Africa	Multinational	34,47
Sardine West Africa Zone A+B	Multinational	34,47
Sardine West Africa Zone C	Multinational	34,47
Anchovy Northern Adriatic Sea	Multinational	37
Sardine Northern Adriatic Sea	Multinational	37
Deep-water Rose Shrimp Northern Spain	Multinational	37
Herring ICES 22-24-IIIa	Multinational	27
Herring Northern Irish Sea	Multinational	27
Herring North Sea	Multinational	27
Herring ICES VIIa-g-h-j	Multinational	27
Herring ICES VIa	Multinational	27
Herring ICES VIa-VIIb-VIIc	Multinational	27
Bigeye tuna Eastern Pacific	Multinational	67,77,87
Striped marlin Northeast Pacific	Multinational	67
Swordfish Eastern Pacific	Multinational	67,77,87
Yellowfin tuna Eastern Pacific	Multinational	67,77,87
Albacore tuna Mediterranean	Multinational	37
Albacore tuna North Atlantic	Multinational	21,27,31,34
Albacore tuna South Atlantic	Multinational	41,47
Bluefin tuna Eastern Atlantic	Multinational	27,34,47,37

Bluefin tuna Western Atlantic	Multinational	21,31,41
Bigeye tuna Atlantic	Multinational	21,27,31,34,41,47,48
Blue marlin Atlantic	Multinational	21,27,31,34,41,47,48
Sailfish Eastern Atlantic	Multinational	27,34,47
Sailfish Western Atlantic	Multinational	21,31,41
Skipjack tuna Eastern Atlantic	Multinational	27,34,47
Skipjack tuna Western Atlantic	Multinational	21,31,41
Swordfish Mediterranean Sea	Multinational	37
Swordfish North Atlantic	Multinational	21,27,31,34
Swordfish South Atlantic	Multinational	41,47
White marlin Atlantic	Multinational	21,27,31,34,41,47,48
Yellowfin tuna Atlantic	Multinational	21,27,31,34,41,47,48
Norway Lobster Balearic Island	Multinational	37
Red Shrimp Northern Spain	Multinational	37
Alfonsino Chile	Multinational	87
Blue Squat Lobster Chilean	Multinational	87
Blue Whiting Chile	Multinational	87
Chilean Herring Chile Region V-X	Multinational	87
Horse Mackerel Chile	Multinational	87
Nylon Shrimp Chile	Multinational	87
Peruvian Anchoveta Chile Region V-X	Multinational	87
Peruvian Anchoveta North Chile	Multinational	87
Peruvian Anchoveta South Chile	Multinational	87
Patagonian grenadier Chile	Multinational	87
Pink Cusk-eel Chile	Multinational	87
Patagonian Toothfish Chile	Multinational	87
Deepwater Cardinalfish Chile	Multinational	87
South Hake Chile	Multinational	87
South Pacific Hake Chile	Multinational	87
Yellownose Skate Chile	Multinational	87
Anchovy Gulf of Lions	Multinational	37
Sardine Gulf of Lions	Multinational	37
Albacore tuna Indian Ocean	Multinational	51,57,58
Bigeye tuna Indian Ocean	Multinational	51,57,58

Skipjack tuna Indian Ocean	Multinational	51,57,58
Swordfish Indian Ocean	Multinational	51,57,58
Yellowfin tuna Indian Ocean	Multinational	51,57,58
Albacore tuna North Pacific	Multinational	61,67
Blue marlin Pacific Ocean	Multinational	61,67,71,77,81,87,88
Pacific bluefin tuna Pacific Ocean	Multinational	61,67,71,77,81,87,88
Striped marlin Western and Central North Pacific	Multinational	61,67,71,77
Swordfish North Pacific	Multinational	61,67
American Plaice NAFO-3LNO	Multinational	21
American Plaice NAFO-3M	Multinational	21
Atlantic cod NAFO 3M	Multinational	21
Atlantic cod NAFO 3NO	Multinational	21
Greenland halibut NAFO 23KLMNO	Multinational	21
Redfish species NAFO 3LN	Multinational	21
Redfish species NAFO 3M	Multinational	21
Yellowtail Flounder NAFO 3LNO	Multinational	21
Capelin Iceland	Multinational	27
Atlantic cod Faroe Plateau	Multinational	27
Atlantic cod Iceland	Multinational	27
Haddock Faroe Plateau	Multinational	27
Haddock Iceland	Multinational	27
Herring Iceland (Summer spawners)	Multinational	27
Pollock Faroe Plateau	Multinational	27
Pollock or saithe Iceland Grounds	Multinational	27
Albacore tuna South Pacific Ocean	Multinational	81,87
Bigeye tuna Central Western Pacific	Multinational	71
Bigeye tuna Western Pacific Ocean	Multinational	61,71,81
Skipjack tuna Central Western Pacific	Multinational	71
Striped marlin Southwestern Pacific Ocean	Multinational	61,71,81
Yellowfin tuna Central Western Pacific	Multinational	71
Chilean jack mackerel Chilean EEZ and offshore	Multinational	87
Sprat Black Sea	Multinational	37
Turbot Black Sea	Multinational	37
Atlantic cod Baltic Areas 22 and 24	Multinational	27
Atlantic cod Baltic Areas 25-32	Multinational	27
Atlantic cod Irish Sea	Multinational	27

Atlantic cod Kattegat	Multinational	27
Atlantic Cod Celtic Sea	Multinational	27
Herring ICES 25-32	Multinational	27
Herring ICES 30	Multinational	27
Herring ICES 31	Multinational	27
Herring ICES 28	Multinational	27
Sprat ICES Baltic Areas 22-32	Multinational	27
Atlantic cod West of Scotland	Multinational	27
Fourspotted megrim ICES VIIIc-IXa	Multinational	27
Hake Northeast Atlantic North	Multinational	27
Hake Northeast Atlantic South	Multinational	27
Megrim ICES VIIIc-IXa	Multinational	27
common European sole Bay of Biscay	Multinational	27
Anchovy ICES VIII	Multinational	27
Mackerel ICES Northeast Atlantic	Multinational	27
European pilchard ICES VIIIc-IXa	Multinational	27
Blue Whiting Northeast Atlantic	Multinational	27
Haddock West of Scotland	Multinational	27
European Plaice Irish Sea	Multinational	27
common European sole Irish Sea	Multinational	27
Whiting ICES VIa	Multinational	27
Atlantic cod North Sea	Multinational	27
Haddock ICES IIIa and North Sea	Multinational	27
Haddock Rockall Bank	Multinational	27
Norway pout North Sea	Multinational	27
European Plaice ICES VIId	Multinational	27
European Plaice ICES IIIa	Multinational	27
European Plaice North Sea	Multinational	27
Pollock ICES IIIa, VI and North Sea	Multinational	27
Sandeel North Sea Area 1	Multinational	27
Sandeel North Sea Area 2	Multinational	27
Sandeel North Sea Area 3	Multinational	27
common European sole ICES Kattegat and Skagerrak	Multinational	27
common European sole North Sea	Multinational	27
common European sole ICES VIId	Multinational	27
Whiting NS-VIId	Multinational	27
Haddock ICES VIIb-k	Multinational	27
European Plaice ICES VIIf-g	Multinational	27

European Plaice ICES VIIe	Multinational	27
common European sole Celtic Sea	Multinational	27
common European sole Western English Channel	Multinational	27
Whiting ICES VIIe-k	Multinational	27
Australian salmon New Zealand	New Zealand	81
Black cardinalfish East coast of North Island	New Zealand	81
Black Oreo Pukaki Rise	New Zealand	81
Giant stargazer NZ Area STA7	New Zealand	81
Hoki Eastern New Zealand	New Zealand	81
Hoki Western New Zealand	New Zealand	81
New Zealand ling New Zealand Areas LIN 3 and 4	New Zealand	81
New Zealand ling New Zealand Areas LIN 5 and 6	New Zealand	81
Orange Roughy Chatham Rise	New Zealand	81
Orange roughy New Zealand Mid East Coast	New Zealand	81
Black Foot Paua NZ North PAUA5A	New Zealand	81
New Zealand abalone species New Zealand Area PAU 7	New Zealand	81
Black Foot Paua NZ South PAUA5A	New Zealand	81
Scampi Bay of Plenty	New Zealand	81
Scampi Wairapa/Hawke Bay	New Zealand	81
Smooth Oreo Bounty Plateau	New Zealand	81
Smooth oreo Chatham Rise	New Zealand	81
Smooth Oreo East Pukaki Rise	New Zealand	81
Smooth Oreo Southland	New Zealand	81
Smooth oreo West end of Chatham Rise	New Zealand	81
Southern hake Chatham Rise	New Zealand	81
Southern hake Sub-Antarctic	New Zealand	81
Tarakihi New Zealand	New Zealand	81
Black oreo West end of Chatham Rise	New Zealand	81
Bluenose New Zealand	New Zealand	81
New Zealand snapper New Zealand Area 8	New Zealand	81
Trevally New Zealand Areas TRE 7	New Zealand	81
Red rock lobster New Zealand area CRA1	New Zealand	81
Red rock lobster New Zealand area CRA2	New Zealand	81
Red rock lobster New Zealand area CRA3	New Zealand	81
Red rock lobster New Zealand area CRA4	New Zealand	81
Red rock lobster New Zealand area CRA5	New Zealand	81
Red rock lobster New Zealand area CRA7	New Zealand	81
Red rock lobster New Zealand area CRA8	New Zealand	81

common gemfish New Zealand	New Zealand	81
New Zealand ling New Zealand Area LIN 6b	New Zealand	81
New Zealand ling New Zealand Area LIN 72	New Zealand	81
New Zealand ling New Zealand Area LIN 7WC - WCSI	New Zealand	81
Southern blue whiting Campbell Island Rise	New Zealand	81
New Zealand abalone species New Zealand Area PAU 5B	New Zealand	81
New Zealand abalone species New Zealand Area PAU 5D	New Zealand	81
Peruvian anchoveta North-Central Peru	Peru	87
Walleye Pollock Navarinsky	Russian Federation	61
Shallow-water cape hake South Africa	South Africa	47,51
Cape horse mackerel South Africa South coast	South Africa	47,51
Deep-water cape hake South Africa	South Africa	47,51
Patagonian toothfish South Africa Subantarctic Prince Edward Islands	South Africa	47,51
Herring Togiak District	USA	67
Alaska plaice Bering Sea and Aleutian Islands	USA	67
Arrowtooth flounder Bering Sea and Aleutian Islands	USA	67
Arrowtooth flounder Gulf of Alaska	USA	67
Atka mackerel Bering Sea and Aleutian Islands	USA	67
Blue king crab Pribilof Islands	USA	67
Dover sole Gulf of Alaska	USA	67
Dusky rockfish Gulf of Alaska	USA	67
Flathead sole Bering Sea and Aleutian Islands	USA	67
Flathead sole Gulf of Alaska	USA	67
Greenland turbot Bering Sea and Aleutian Islands	USA	67
Northern rockfish Bering Sea and Aleutian Islands	USA	67
Northern rockfish Gulf of Alaska	USA	67
Northern rock sole Eastern Bering Sea and Aleutian Islands	USA	67
Pacific cod Bering Sea and Aleutian Islands	USA	67
Pacific cod Gulf of Alaska	USA	67
Pacific Ocean perch Eastern Bering Sea and Aleutian Islands	USA	67
Pacific ocean perch Gulf of Alaska	USA	67
Rex sole Gulf of Alaska	USA	67
Rougheye rockfish Bering Sea and Aleutian Islands	USA	67
Rougheye rockfish Gulf of Alaska	USA	67
Red king crab Bristol Bay	USA	67
Red king crab Pribilof Islands	USA	67
Sablefish Eastern Bering Sea / Aleutian Islands / Gulf of Alaska	USA	67

Snow crab Bering Sea	USA	67
Tanner crab Bering Sea and Aleutian Islands	USA	67
Walleye pollock Aleutian Islands	USA	67
Walleye pollock Eastern Bering Sea	USA	67
Walleye pollock Gulf of Alaska	USA	67
Yellowfin sole Bering Sea and Aleutian Islands	USA	67
Atlantic croaker Mid-Atlantic Coast	USA	21,31
American lobster Georges Bank	USA	21
American lobster Gulf of Maine	USA	21
American lobster Southern New England	USA	21
Northern shrimp Gulf of Maine	USA	21
Blue Crab Chesapeake Bay	USA	21
Acadian redfish Gulf of Maine / Georges Bank	USA	21
American Plaice NAFO-5YZ	USA	21
Atlantic Halibut NAFO-5YZ	USA	21
Bluefish Atlantic Coast	USA	21
Black sea bass Mid-Atlantic Coast	USA	21,31
Atlantic butterfish Gulf of Maine / Cape Hatteras	USA	21
Atlantic cod Georges Bank	USA	21
Atlantic cod Gulf of Maine	USA	21
Haddock NAFO-5Y	USA	21
Haddock Georges Bank	USA	21
Atlantic herring Northwestern Atlantic Coast	USA	21
Monkfish Gulf of Maine / Northern Georges Bank	USA	21
Monkfish Southern Georges Bank / Mid-Atlantic	USA	21,31
Pollock NAFO-5YZ	USA	21
Sea scallop Georges Bank and Mid-Atlantic Bight	USA	21,31
Scup Atlantic Coast	USA	21
Spiny dogfish Atlantic Coast	USA	21
Summer flounder Mid-Atlantic Coast	USA	21,31
Atlantic surfclam Mid-Atlantic Coast	USA	21,31
Tilefish Mid-Atlantic Coast	USA	21,31
Weakfish Atlantic Coast	USA	21
White hake Georges Bank / Gulf of Maine	USA	21
Windowpane flounder - Gulf of Maine / Georges Bank	USA	21
Windowpane Southern New England-Mid Atlantic	USA	21,31
Winter Flounder NAFO-5Z	USA	21
Winter Flounder Southern New England-Mid Atlantic	USA	21,31

Witch Flounder NAFO-5Y	USA	21
Yellowtail flounder Cape Cod / Gulf of Maine	USA	21
Yellowtail flounder Georges Bank	USA	21
Yellowtail Flounder Southern New England-Mid Atlantic	USA	21,31
Atlantic menhaden Atlantic	USA	21,31
Striped marlin North Pacific	USA	61,67
Arrowtooth flounder Pacific Coast	USA	67,77
Blackgill rockfish Pacific Coast	USA	67,77
Black rockfish Northern Pacific Coast	USA	67,77
Black rockfish Southern Pacific Coast	USA	77
Blue rockfish California	USA	77
Cabezon Oregon Coast	USA	67
Chilipepper Southern Pacific Coast	USA	77
Canary rockfish Pacific Coast	USA	67,77
Darkblotched rockfish Pacific Coast	USA	67
English sole Pacific Coast	USA	67
Kelp greenling Oregon Coast	USA	67
Lingcod Northern Pacific Coast	USA	67,77
Lingcod Southern Pacific Coast	USA	77
Longnose skate Pacific Coast	USA	67
Longspine thornyhead Pacific Coast	USA	67
Pacific hake Pacific Coast	USA	67
Pacific ocean perch Pacific Coast	USA	67
Sablefish Pacific Coast	USA	67
Splitnose Rockfish Pacific Coast	USA	67
Spotted spiny dogfish Pacific Coast	USA	67
Shortspine thornyhead Pacific Coast	USA	67
Widow rockfish Pacific Coast	USA	67
Yelloweye rockfish Pacific Coast	USA	67
Yellowtail rockfish Northern Pacific Coast	USA	67,77
Bank Rockfish California	USA	77
Bocaccio Southern Pacific Coast	USA	77
Cabezon Northern California	USA	77
Cabezon Southern California	USA	77
Cowcod Southern California	USA	77
Greenstriped rockfish Pacific Coast	USA	67,77
Petrale sole Pacific Coast	USA	67
Black Grouper Gulf of Mexico and South Atlantic	USA	31

Brown shrimp Gulf of Mexico	USA	31
Black sea bass South Atlantic	USA	31
Gag Gulf of Mexico	USA	31
Greater amberjack Gulf of Mexico	USA	31
King mackerel Gulf of Mexico	USA	31
Longfin inshore squid Atlantic Coast	USA	31
Pink shrimp Gulf of Mexico	USA	31
Red grouper Gulf of Mexico	USA	31
Red grouper South Atlantic	USA	31
Red porgy Southern Atlantic coast	USA	31
Red snapper Southern Atlantic coast	USA	31
Snowy grouper Southern Atlantic coast	USA	31
Spanish mackerel Gulf of Mexico	USA	31
Spanish mackerel Southern Atlantic Coast	USA	31
Tilefish Gulf of Mexico	USA	31
Tilefish Southern Atlantic coast	USA	31
Vermilion snapper Gulf of Mexico	USA	31
Vermilion snapper Southern Atlantic coast	USA	31
White shrimp Gulf of Mexico	USA	31
Yellowedge grouper Gulf of Mexico	USA	31
Yellowtail Snapper Southern Atlantic Coast and Gulf of Mexico	USA	31
California scorpionfish Southern California	USA	77
Pacific chub mackerel Pacific Coast	USA	77
Dover sole Pacific Coast	USA	77
Gopher rockfish Southern Pacific Coast	USA	77
Greenspotted rockfish Pacific Coast North	USA	77
Greenspotted rockfish Pacific Coast South	USA	77
Pacific sardine Pacific Coast	USA	77
Shortbelly rockfish Pacific Coast	USA	77
Starry flounder Northern Pacific Coast	USA	67,77
Starry flounder Southern Pacific Coast	USA	77
Pacific Geoduck Washington	USA	67

Table S3. Description of variables available for inclusion in the panel regression model.

Variable	Description
Variable	**Description**
Inverse age of fishery	Age of fishery in year t, such that variable is largest at a fishery's start and 1 in the current year
Scaled harvest 4 years ago	Scaled harvest four years before present
Scaled harvest 3 years ago	Scaled harvest three years before present
Scaled harvest 2 years ago	Scaled harvest two years before present
Scaled harvest 1 year ago	Scaled harvest one year before present
Scaled harvest at current year	Scaled harvest in current year
Years to max harvest	Number of years from the start of the fishery until the maximum recorded harvest occurs
Initial slope of harvest	Slope of harvest over the fishery's first six years
Maximum harvest	Maximum recorded harvest for the fishery
Running harvest ratio	Ratio of harvest in the current year to the maximum harvest to have occurred prior to the current year
Mean scaled harvest	Mean scaled harvest for the fishery
Von Bertalanffy *K*	Von Bertalanffy growth rate parameter
Temperature	Mean preferred temperature range of the species
Geographic distribution of species	Area of the biologic range of the species
Maximum length	Maximum recorded length for the species
Age at maturity	Age at which 50% of the individuals are sexually mature for the species
ISSCAAP categories	Fixed effect for the species groups included in each regression model
Constant	Constant term

Table S4. FAO major fishing statistical zones and corresponding codes.

Marine Areas	**Zone**	**Code**
Atlantic Ocean and adjacent seas		
	Arctic Sea	18
	Atlantic, Northwest	21
	Atlantic, Northeast	27
	Atlantic, West Central	31
	Atlantic, Eastern Central	34
	Mediterranean and Black Sea	37
	Atlantic, Southwest,	41
	Atlantic, Southeast	47
Indian Ocean		
	Indian Ocean, Western	51
	Indian Ocean, Eastern	57
Pacific Ocean		
	Pacific, Northwest	61
	Pacific, Northeast	67
	Pacific, Western Central	71
	Pacific, Eastern Central	77
	Pacific, Southwest	81
	Pacific, Southeast	87
Southern Ocean		
	Atlantic, Antarctic	48
	Indian Ocean, Antarctic	58
	Pacific, Antarctic	88

Table S5. ISSCAAP species categories and whether or not catch is aggregated by FAO region for stocks within that category.

Species Category (ISSCAAP)	Grouped (Yes/No)
Abalones, winkles, conchs	No
Carps, barbels and other cyprinids	No
Clams, cockles, arkshells	No
Cods, hakes, haddocks	Yes
Crabs, sea-spiders	No
Flounders, halibuts, soles	No
Herrings, sardines, anchovies	No
Horseshoe crabs and other arachnoids	No
King crabs, squat-lobsters	No
Lobsters, spiny-rock lobsters	No
Miscellaneous aquatic invertebrates	No
Miscellaneous coastal fishes	No
Miscellaneous demersal fishes	No
Miscellaneous demersal fishes	No
Miscellaneous diadromous fishes	No
Miscellaneous marine crustaceans	No
Miscellaneous pelagic fishes	Yes
Mussels	No
Oysters	No
Salmons, trouts, smelts	No
Scallops, pectens	No
Sea-urchins and other echinoderms	No
Shads	No
Sharks, rays, chimaeras	No
Shrimps, prawns	No
Squids, cuttlefishes, octopuses	No
Sturgeons, paddlefishes	No
Tunas, bonitos, billfishes	Yes

Table S6. Summary statistics for model 1.

	Model 1
(Intercept)	-2.75 (0.11)***
YearsBack	0.01 (0.00)***
ScaledCatch	0.29 (0.16)
ScaledCatch1Back	0.20 (0.17)
ScaledCatch2Back	0.07 (0.17)
ScaledCatch3Back	0.04 (0.16)
ScaledCatch4Back	-0.12 (0.13)
MaxCatch	0.00 (0.00)
TimeToMaxCatch	0.02 (0.00)***
InitialScaledCatchSlope	-4.05 (0.41)***
MeanScaledCatch	0.63 (0.16)***
CatchToRollingMax	0.91 (0.10)***
MaxLength	0.00 (0.00)*
AgeMat	0.03 (0.00)***
VonBertK	-0.18 (0.10)
Temp	0.03 (0.01)***
SpeciesCatNameFlounders, halibuts, soles	0.72 (0.07)***
SpeciesCatNameHerrings, sardines, anchovies	0.61 (0.06)***
SpeciesCatNameMiscellaneous coastal fishes	0.67 (0.20)***
SpeciesCatNameMiscellaneous demersal fishes	1.17 (0.10)***
SpeciesCatNameMiscellaneous pelagic fishes	-0.42 (0.10)***
SpeciesCatNameSharks, rays, chimaeras	0.80 (0.23)***
SpeciesCatNameTunas, bonitos, billfishes	0.44 (0.09)***
R^2	0.48
Adj. R^2	0.47
Num. obs.	3240
RMSE	0.86

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Table S7. Summary statistics for model 2.

	Model 2
(Intercept)	-1.05 (0.07)***
YearsBack	0.00 (0.00)
ScaledCatch	-0.39 (0.11)***
ScaledCatch1Back	0.27 (0.11)**
ScaledCatch2Back	0.09 (0.10)
ScaledCatch3Back	0.01 (0.10)
ScaledCatch4Back	-0.14 (0.08)
MaxCatch	-0.00 (0.00)***
TimeToMaxCatch	0.01 (0.00)***
InitialScaledCatchSlope	-0.42 (0.22)
MeanScaledCatch	0.32 (0.11)**
CatchToRollingMax	1.46 (0.07)***
MaxLength	-0.00 (0.00)***
AgeMat	0.02 (0.00)***
VonBertK	0.02 (0.08)
SpeciesCatNameFlounders, halibuts, soles	-0.41 (0.04)***
SpeciesCatNameHerrings, sardines, anchovies	-0.06 (0.04)
SpeciesCatNameMiscellaneous coastal fishes	0.10 (0.04)*
SpeciesCatNameMiscellaneous demersal fishes	0.54 (0.04)***
SpeciesCatNameMiscellaneous pelagic fishes	-0.21 (0.05)***
SpeciesCatNameSharks, rays, chimaeras	0.72 (0.24)**
SpeciesCatNameTunas, bonitos, billfishes	0.48 (0.04)***
R^2	0.32
Adj. R^2	0.32
Num. obs.	8075
RMSE	0.94

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Table S8. Summary statistics for model 3.

	Model 3
(Intercept)	−0.88 (0.32)**
YearsBack	0.00 (0.00)***
ScaledCatch	−0.25 (0.10)*
ScaledCatch1Back	0.24 (0.09)**
ScaledCatch2Back	0.08 (0.09)
ScaledCatch3Back	−0.00 (0.09)
ScaledCatch4Back	−0.19 (0.07)**
MaxCatch	−0.00 (0.00)***
TimeToMaxCatch	0.01 (0.00)***
InitialScaledCatchSlope	0.20 (0.20)
MeanScaledCatch	0.35 (0.09)***
CatchToRollingMax	1.26 (0.06)***
MaxLength	−0.00 (0.00)***
VonBertK	0.21 (0.07)**
SpeciesCatNameCods, hakes, haddocks	−0.31 (0.31)
SpeciesCatNameFlounders, halibuts, soles	−0.58 (0.31)
SpeciesCatNameHerrings, sardines, anchovies	−0.26 (0.31)
SpeciesCatNameLobsters, spiny-rock lobsters	−1.19 (0.43)**
SpeciesCatNameMiscellaneous coastal fishes	−0.23 (0.31)
SpeciesCatNameMiscellaneous demersal fishes	0.42 (0.31)
SpeciesCatNameMiscellaneous pelagic fishes	−0.67 (0.31)*
SpeciesCatNameSharks, rays, chimaeras	0.66 (0.39)
SpeciesCatNameShrimps, prawns	−0.25 (0.35)
SpeciesCatNameTunas, bonitos, billfishes	0.22 (0.31)
R^2	0.32
Adj. R^2	0.32
Num. obs.	9475
RMSE	0.92

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Table S9. Summary statistics for model 4.

	Model 4
(Intercept)	$-0.82\ (0.31)^{**}$
YearsBack	$0.00\ (0.00)^{***}$
ScaledCatch	$-0.23\ (0.09)^{**}$
ScaledCatch1Back	$0.25\ (0.09)^{**}$
ScaledCatch2Back	$0.06\ (0.08)$
ScaledCatch3Back	$-0.01\ (0.08)$
ScaledCatch4Back	$-0.21\ (0.07)^{**}$
MaxCatch	$-0.00\ (0.00)^{***}$
TimeToMaxCatch	$0.01\ (0.00)^{***}$
InitialScaledCatchSlope	$0.16\ (0.19)$
MeanScaledCatch	$0.28\ (0.09)^{**}$
CatchToRollingMax	$1.17\ (0.06)^{***}$
VonBertK	$0.39\ (0.06)^{***}$
SpeciesCatNameCods, hakes, haddocks	$-0.53\ (0.31)$
SpeciesCatNameFlounders, halibuts, soles	$-0.61\ (0.31)^{*}$
SpeciesCatNameHerrings, sardines, anchovies	$-0.40\ (0.31)$
SpeciesCatNameLobsters, spiny-rock lobsters	$-1.20\ (0.42)^{**}$
SpeciesCatNameMiscellaneous coastal fishes	$-0.38\ (0.31)$
SpeciesCatNameMiscellaneous demersal fishes	$0.24\ (0.31)$
SpeciesCatNameMiscellaneous pelagic fishes	$-0.81\ (0.31)^{**}$
SpeciesCatNameSharks, rays, chimaeras	$0.23\ (0.32)$
SpeciesCatNameShrimps, prawns	$-0.24\ (0.35)$
SpeciesCatNameTunas, bonitos, billfishes	$-0.20\ (0.31)$
R^2	0.30
Adj. R^2	0.30
Num. obs.	10463
RMSE	0.91

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Table S10. Summary statistics for model 5.

	Model 5
(Intercept)	-0.66 (0.07)***
YearsBack	0.01 (0.00)***
ScaledCatch	-0.11 (0.08)
ScaledCatch1Back	0.20 (0.07)**
ScaledCatch2Back	0.02 (0.07)
ScaledCatch3Back	-0.03 (0.07)
ScaledCatch4Back	-0.20 (0.06)***
MaxCatch	-0.00 (0.00)***
TimeToMaxCatch	0.01 (0.00)***
InitialScaledCatchSlope	0.77 (0.15)***
MeanScaledCatch	0.04 (0.07)
CatchToRollingMax	1.07 (0.05)***
SpeciesCatNameClams, cockles, arkshells	0.57 (0.16)***
SpeciesCatNameCods, hakes, haddocks	-0.48 (0.07)***
SpeciesCatNameCrabs, sea-spiders	-0.06 (0.10)
SpeciesCatNameFlounders, halibuts, soles	-0.42 (0.07)***
SpeciesCatNameHerrings, sardines, anchovies	-0.16 (0.07)*
SpeciesCatNameKing crabs, squat-lobsters	0.20 (0.11)
SpeciesCatNameLobsters, spiny-rock lobsters	-0.69 (0.08)***
SpeciesCatNameMiscellaneous coastal fishes	-0.42 (0.07)***
SpeciesCatNameMiscellaneous demersal fishes	0.22 (0.07)**
SpeciesCatNameMiscellaneous pelagic fishes	-0.70 (0.07)***
SpeciesCatNameScallops, pectens	-0.87 (0.13)***
SpeciesCatNameSharks, rays, chimaeras	0.19 (0.10)*
SpeciesCatNameShrimps, prawns	-0.64 (0.10)***
SpeciesCatNameSquids, cuttlefishes, octopuses	0.60 (0.17)***
SpeciesCatNameTunas, bonitos, billfishes	-0.08 (0.07)
R^2	0.27
Adj. R^2	0.27
Num. obs.	13611
RMSE	0.90

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Table S11. Resilience classification and corresponding priors on the growth parameter *g* of the Pella-Tomlinson surplus production model. All priors come from uniform distributions (U).

Resilience	**Prior on *g***
Very Low	$\phi/(1+\phi)$ U~[0.001,0.05]
Low	$\phi/(1+\phi)$ U~[0.05,0.15]
Medium	$\phi/(1+\phi)$ U~[.15,0.5]
High	$\phi/(1+\phi)$ U~[0.5,1]

Table S12. ISSCAAP categories and their assigned commodity categories per Delgado *et al.***(13)**. Asterisks indicate ISSCAAP categories that did not exactly match the classifications of Delgado *et al.***(13)** and were categorized by the authors. ISSCAAP categories not included in Delgado *et al.***(13)** were categorized as 'Other marine animals'.

Species Category (ISSCAAP)	**Commodity Category**
Crabs, sea-spiders	Crustaceans
Lobsters, spiny-rock lobsters	Crustaceans
Shrimps, prawns	Crustaceans
Miscellaneous marine crustaceans	Crustaceans
Horseshoe crabs and other arachnoids	Crustaceans
King crabs, squat-lobsters	Crustaceans*
Sturgeons, paddlefishes	High-value finfish
Salmons, trouts, smelts	High-value finfish
Flounders, halibuts, soles	High-value finfish
Cods, hakes, haddocks	High-value finfish
Tunas, bonitos, billfishes	High-value finfish
Sharks, rays, chimaeras	High-value finfish
Carps, barbels and other cyprinids	Low-value finfish
Tilapias and other cichlids	Low-value finfish
Shads	Low-value finfish
Miscellaneous diadromous fishes	Low-value finfish
Herrings, sardines, anchovies	Low-value finfish
Marine fishes not identified	Low-value finfish
Miscellaneous coastal fishes	Low-value finfish*
Miscellaneous demersal fishes	Low-value finfish*
Miscellaneous pelagic fishes	Low-value finfish*
Abalones, winkles, conchs	Mollusks
Oysters	Mollusks
Mussels	Mollusks
Scallops, pectens	Mollusks
Clams, cockles, arkshells	Mollusks
Squids, cuttlefishes, octopuses	Mollusks
Miscellaneous marine molluscs	Mollusks
Sea-urchins and other echinoderms	Other marine animals
Miscellaneous aquatic invertebrates	Other marine animals

Table S13. Reference list and economic effects of RBFM reforms. We adopt the mean price increase (31%) and cost reduction (-23%) for the RBFM policy.

STUDY	**Fishery/Species**	**Percent Change**	**Reason**
Prices	Mean	31%	
Grainger and Costello, 2016(22)	US Gulf of Mexico Red Snapper	39%	Product quality; season length
Hermann, 2000 (23)	British Colombia halibut	17%	Season length; more fresh product
Diekert *et al.*, 2014 (24)	Norwegian coastal cod	0%	No derby fishing prior to ITQ
Dupont *et al.*, 2005 (17)	Canadian Scotia-Fundy mobile gear fishery (cod)	43%	Better handling; longer, even seasons
Dupont *et al.*, 2005	Canadian Scotia-Fundy mobile gear fishery (haddock)	18%	Better handling; longer, even seasons
Dupont *et al.*, 2005	Canadian Scotia-Fundy mobile gear fishery (pollock)	22%	Better handling; longer, even seasons
Gauvin *et al.*, 1994 (18)	US South Atlantic wreckfish	19%	Season length
Hermann and Criddle, 2006 (19)	Alaska halibut	12%	Season length; more fresh product
Tveteras *et al.*, 2011 (20)	Peruvian anchoveta	37%	Season length
Geen and Nayar, 1988 (21)	Australian southern Bluefin tuna	102%	Higher price markets; target larger fish
Costs	Mean	-23%	
Diekert *et al.*, 2014	Norwegian coastal cod	-15%	Eliminated the race to fish
Dupont *et al.*, 2005	Canadaian Scotia-Fundy mobile gear fishery	-6%	Adjust input usage to lower costs
Sigler and Lunsford, 2001 (25)	Alaska sablefish longline	-38%	Decreased variable costs (fuel, bait, gear)
Weninger, 1998 (26)	US Atlantic surfclam and ocean quahog	-44%	Fleet restructuring
Solis *et al.*, 2015 (27)	US Gulf of Mexico red snapper	-10%	Exit of less efficient vessels; easing of control regulations
Geen and Nayar, 1998	Australian southern Bluefin tuna	-26%	Lower costs per ton

Table S14. Fishing costs as a fraction of revenue and per metric ton (MT) of catch in the baseline year (2012). Results suggest that profitability varies considerably across ISSCAAP categories.

ISSCAAP Category	**Median Ratio**	**Mean Ratio**	**Median $/MT**	**Mean $/MT**
Cods, hakes, haddocks	0.59	0.76	768	1,263
Herrings, sardines, anchovies	0.47	0.47	186	247
Flounders, halibuts, soles	0.68	0.85	1,848	3,348
Miscellaneous coastal fishes	0.79	0.80	1,680	1,915
King crabs, squat-lobsters	0.25	0.29	2,095	2,437
Miscellaneous demersal fishes	0.37	0.42	384	789
Crabs, sea-spiders	0.58	0.51	1,987	1,782
Lobsters, spiny-rock lobsters	0.86	0.79	11,590	10,660
Shrimps, prawns	1.04	0.90	3,392	3,277
Tunas, bonitos, billfishes	0.50	0.61	880	1,165
Scallops, pectens	0.81	0.69	1,396	1,213
Miscellaneous pelagic fishes	0.62	0.71	628	911
Sharks, rays, chimaeras	0.51	0.60	282	463
Clams, cockles, arkshells	0.22	0.48	240	590
Abalones, winkles, conchs	0.53	0.50	806	2,127
Squids, cuttlefishes, octopuses	0.21	0.21	418	492
Shads	0.18	0.30	136	228
Salmons, trouts, smelts	0.33	0.43	748	1,047
Miscellaneous aquatic invertebrates	0.17	0.17	56	56
Miscellaneous diadromous fishes	0.30	0.50	244	423
Mussels	0.98	0.99	382	363
Sea-urchins and other echinoderms	0.18	0.18	456	394
Oysters	0.55	0.49	492	443
Carps, barbels and other cyprinids	0.34	0.34	340	340
Miscellaneous marine crustaceans	0.92	0.87	3,146	2,871
Horseshoe crabs and other arachnoids	0.18	0.18	630	630

Table S15. Global results for all policies (BAU, RBFM, and F_{MSY}) and scenarios (conservation and all stocks) in 2050 as presented in Figure 3.

Policy	**Biomass (MMT)**	**2050 Profit ($ Billions)**	**Harvest (MMT)**
Business As Usual CC	817.3	44.1	58.2
Business As Usual	524.3	26.1	54.6
RBFM CC	1,228.0	74.9	64.1
RBFM	1,143.4	79.4	70.6
FMSY CC	822.6	48.5	73.1
FMSY	994.4	58.1	64.1
Today	840.3	43.7	62.4

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