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Supplementary Materials for

Status and Solutions for the World's Unassessed Fisheries

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Correction: Tables S8, S11, and S12 have been updated to exactly match the figures in the main text.

Materials and Methods

1. Model Construction

1.1 Model and Results

Our approach proceeds in two steps. The first step is to estimate a panel regression model (PRM) using data from the assessed fisheries that relates the log(B/B_{msy}) to sets of catch history data, fishery development characteristics, biological characteristics, a time trend, and fixed effects for species type. The second step uses the regression coefficient estimates to predict B/B_{msy} for the unassessed fisheries using the same variables included in the regression model (see below for methods). Making predictions for the level of B/B_{msy} using coefficients from a log-linear model for B/B_{msy}, leads to the so-called re-transformation bias problem (*28*). Below we describe the method we use to address this problem.

For expositional simplicity, suppose there is a single predictor for log(B/B_{msy}), X_{ijt}, where i denotes fishery, j denotes species type and t represent calendar year. The baseline panel regression model is:

$$(1) \quad log\left(\frac{B}{B_{msy}}\right)_{ijt} = \alpha + \beta X_{ijt} + \gamma_j + \delta t + \varepsilon_{ijt}$$

where α is a constant term, β is the regression effect of X_{ijt} on log(B/B_{msy}), γ_j is a species fixed effect, δ is a time effect, and ε_{ijt} is an error term. Table S1 lists all the variables included in the models. Species fixed effects were created using the species categories defined by ISSCAAP. Coefficients for the species type fixed effects are relative to the group "flounders, halibut, and soles". The species fixed effects will control for all unobserved time-invariant factors that are species specific and correlated with log(B/B_{msy}). "Scaled" refers to the scaling for each fishery of harvest variables by the maximum-recorded harvest for that fishery.

Using the regression estimates of α, β, γ, and δ from this model, we can predict B/B_{msy} for unassessed fisheries, as long as we have access to data on X_{ijt} for unassessed fisheries. It is simpler to consider making a prediction for a specific year (e.g., 2009). A naïve value for the predicted B/B_{msy} (denoted as B/B_{msy}*) for fishery i, from species family j, in year t=τ is given by:

$$(2) \quad \left(\frac{B}{B_{msy}}\right)^*_{ij\tau} = \exp\left(\hat{\alpha} + \hat{\beta} X_{ij\tau} + \hat{\gamma}_j + \hat{\delta}\tau\right)$$

While this method is known to provide a biased estimate of the conditional mean (*28*), it is an accurate prediction of the conditional median of a given fishery. However, to generate a prediction of the median across a group of fisheries, one needs to be careful about the retransformation bias (see below for methods to correct for this bias).

Since it was not possible to collect all variables listed in Table S1 for all unassessed fisheries, we estimated 6 separate models with different sets of variables included. Model 1 makes use of all the regressors contained in our database. Each subsequent model was created by sequentially dropping the variable that increases the number of valid fisheries observations the most. For any given fishery, the model utilizing the most data possible was used to calculate B/Bmsy. Table S2 contains the coefficients and significance levels of the variables in models 1 through 6. Variables marked as "NaN" under a model are the variables that were omitted in that model.

The regression coefficients were estimated with a dataset of 204 stock-assessed fisheries from the RAM II Legacy database (*5*). Each regression was estimated in STATA, with the variance-covariance matrix clustered by the individual fisheries.

1.2 Bias Correction

Our regression model allows us to make individual predictions about the log(B/B_{msy}) for any given unassessed fishery. But due to the retransformation bias problem, the exponential of this value provides a biased estimate of the mean of B/B_{msy} for any given fishery. Correction methods for the mean prediction are widely available (e.g., *28*). However, if we wish to use our estimates to predict the median of a group of fisheries (e.g. all global unassessed fisheries), a bias may still exist. This section describes how we correct for this possible bias.

Denote $y_{it}=B_{it}/B_{imsy}$ for fishery i in year t. The model is: $\log(y_{it}) = x_{it}\beta + e_{it}$, where $e_{it} \sim N(0, \sigma_{it}^2)$. The subscripts on the variance allow for the possibility of heteroskedasticity. A naïve estimate of y_{it} is exp($x_{it}\beta$, which is the conditional median of y_{it}, but is not the conditional mean of y_{it} (due to the well-known "retransformation bias" problem).

Suppose one wishes to use the regression output (the estimate of β, which we denote $\hat{\beta}$) to estimate the median value of a group of fisheries {1, 2, …, N} in some year T. For reasons related to the retransformation bias, one cannot simply take the median of the individual median estimates, $\exp(x_{iT}\hat{\beta})$. We adopt a bootstrap approach and follow this procedure:

Simulate a period T matrix S that has dimension NxJ, where J is the number of bootstrap samples (e.g., 1000) and $S_{ij} = x_{iT}\hat{\beta} + e_{iT}$, where $e_{iT} \sim N(0, \vartheta_{iT}^2)$ (see below for the calculation of ϑ_{iT}^2.

Take the median of each column (i.e., for each bootstrap sample). For column j, the median is: $m_j^T = Median(S_{1j}, \dots, S_{Nj})$

Transform m_j^T to provide an estimate of the un-logged median, form simulation j, as follows: $z_j^T = \exp(m_j^T)$.

The J such median estimates provide a bootstrapped distribution of the desired median B/B_{msy} across the N fisheries. The mean of this bootstrapped distribution gives the expected value of the median across the fisheries. The 95% confidence interval is calculated by the upper and lower 2.5% confidence limits of the bootstrapped distribution.

The variance of the error term in the simulated matrix S is calculated as follows:

We calculate ϑ_{iT}^2 from the fitted residuals from the regression of stock assessed fisheries. To allow for heteroskedasticity, we allow ϑ_{iT}^2 to depend on the magnitude of $\exp(x_{iT}\hat{\beta})$ (with two bins, above and below 0.9) and on year.

For fishery i in year T we first calculate the appropriate "bin" by calculating $\exp(x_{iT}\hat{\beta})$. If this value is below 0.9 it is in bin 1, and if it is above 0.9 it is in bin 2. We then take the fitted residuals from assessed fisheries in that bin, year combination and fit a normal distribution to those residuals. The variance of that fitted normal distribution is our estimate of ϑ_{iT}^2.

Note that we have performed hundreds of robustness checks on these calculations and have found the output to be highly insensitive to the manner of heteroskedasticity allowed (e.g. whether it is time-invariant, whether we use more or fewer bins, etc.). Rather than simulating values drawn from a normal distribution with variance ϑ_{iT}^2 we have also performed a nonparametric bootstrap where we drew from the pool of fitted residuals. None of the variants have any qualitative effect on our results.

Figure S1 graphs the stock assessed results for each of the 6 models. Each subplot gives the predicted median B/B_{msy}, the actual median B/B_{msy}, and the 95% confidence interval over the median.

2. Unassessed Fisheries

2.1 Selection of Unassessed Fisheries

We use the landings data maintained by the FAO to create our database of unassessed fisheries (*6*). The FAO organizes these data by species caught by nations within an FAO statistical region (Fig. S2; Table S3). The FAO landings data are in theory supposed to encompass both recreational and commercial fisheries, but in reality nearly always reflect only commercial catches (*19*). Each fishery in our database is intended to represent a complete stock. For many of our fisheries, we assume that a stock is encompassed by the catch history of a nation within an FAO region. However, we realize that this assumption will be more or less appropriate for different species, depending on their natural range of movement. For some species we set a fishery as equal to the sum of all landings for a given species within an FAO region. We determined which species are grouped in this fashion according to their classification within the categories provided by the International Standard Statistical Classification of Aquatic Animals and Plants (ISSCAAP) (Table S4). However, there is little we can do to correct for fisheries with highly localized populations; there are not sufficient data available at a global level to break down landings into finer spatial scales that might more accurately represent biological stocks of highly localized species. As a result, our assumption about the scale of a biological stock may mask changes in the landings histories of smaller individual stocks. For example, for a highly localized species, it is possible for landings at the scale of the FAO database to remain stable, while in fact representing a series of serial depletions in which fishing effort has collapsed individual stocks and moved on to historically underfished populations. Conversely, recovery of small stocks that have been closed by management might also not be noticeable under the resolution of our model. It is unclear whether the masking of localized stocks by our model would have a biased effect on our estimates of B/B_{msy}, or simply add a source of error.

Each of our fisheries must meet certain data coverage standards in order to be included in our analysis. To account for the fact that many fisheries have negligible catch levels for their early years, catch data are only included in our analysis once a fishery's landings reach a level equal to or greater than 15% of its maximum lifetime recorded landings. Within this resulting time series, because our model makes use of harvest lags, we require that a fishery have at least seven years of catch data. The analysis was also calculated using a minimum requirement of twenty years of catch data, but results did not change significantly. Within the time series of catch for a fishery, individual years are often missing data. For fisheries missing less than 10% of their landings data, missing data points were filled in by interpolation. Any fishery missing more than 10% of its catch data was excluded from the analysis. Excluding fisheries that require any interpolation does not change results significantly, but reduces the sample size by over 1000 fisheries, and thus we chose to keep these fisheries in the analysis. Our resulting database contains 1,793 fisheries distributed throughout the globe (Fig. S3). The median annual landings for these fisheries in 2009 is 770 tons, though nearly 500 of the 1,793 fisheries in our database have average landings over this period greater than 3500 tons (Fig. S4). 554 separate species are included in the final database of 1,793 unassessed fisheries (Table S5).

While our model provides information on a great number of previously unassessed stocks, due to data limitations our coverage of certain regions is not complete. For example, comparing the total 2009 landings in FAO region 61, which are included in our model, to the total landings of unassessed fisheries in that region reported by the FAO, our method only accounts for 35% of the unassessed catch. However, for more data rich regions such as FAO area 67, which includes Alaska, our method accounts for 76% of the unassessed landings reported by the FAO (Table S6). In the main text, estimates of B/B_{msy} for unassessed fisheries begin in 1979, the year after which more than half of landings are accounted for by our method.

3. Data Sources

Data for this analysis came from three publically available databases, the RAM Legacy Stock Assessment Database (*5*), the 2009 FAO fisheries production database (*6*), and FishBase (*15*).

3.1 RAM Legacy Stock Assessment Database

The set of models used in this analysis were fit to data available in the RAM Legacy database (*5;* http://ramlegacy.marinebiodiversity.ca/ram-legacy-stock-assessment-database). Our analysis was performed using a static copy of the database downloaded in July 2011. The RAM database provides time series of B/B_{msy}, SSB/SSB_{msy}, and landings for stock assessed fisheries. For the purposes of this study, SSB/SSB_{msy} was assumed to be approximately equivalent to B/B_{msy}. These data were paired with best available data on the life history of the stock assessed species to train the six panel regression models used in this analysis.

3.2 FAO Fishery Production Database

Landings data for unassessed fisheries were drawn from the 2011 release of the FAO fishery capture production database (*6*). These data can be accessed using the FishStat Plus program publically available from the FAO (http://www.fao.org/fishery/statistics/software/fishstat/en). Only landings data for marine finish identified to the scientific genus and species level were included in this analysis.

3.3 FishBase

Life history data for each species in our unassessed fisheries database were queried from a static version of the publically available FishBase database (*15*; http://www.fishbase.org) purchased from FishBase in March 2011 (specific life history variables selected can be found in Table S1). 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.

Supplementary Text

4. Validation of Results

4.1 Jackknife Analysis

We ran a jackknife routine in order to test the ability of our model to predict out of sample. Each stock assessed fishery was sequentially removed from the set of stock assessed fisheries used to fit our PRM models. The resulting regression was then used to predict B/B_{msy} for the omitted fishery. We then plotted the jackknifed prediction for each omitted fishery against its known B/B_{msy} value. Our results show that our model is able to predict out of sample with reasonable accuracy (Fig. S5).

4.2 Comparison to FAO Fishery Assessments

We used the above methods to predict the status of 1,793 unassessed fisheries worldwide, as described in the main text. One approach to validation is to match our PRM results to an independent database of fishery state of exploitation classifications compiled by the FAO (*29*). We condensed the FAO's classifications into three categories: "over exploited", "fully exploited", and "under exploited". The fisheries classified by the FAO had a median catch of 26,000 tons in 2002 (Fig. S6), far greater than the median catch of 693 tons within our database of unassessed fisheries in that year. We matched each fishery classified by the FAO with the same fishery in our unassessed database. Matching was done by identifying pairings among country, FAO region, and species between the unassessed fishery database and the FAO's assessment database. We then used a box plot to compare the values of B/B_{msy} predicted by our method among the categories (Fig. S7).

Our predictions matched well with the FAO in relative magnitude for all exploitation categories. This correspondence was preserved when we restricted the sample to only those fisheries we classified as "grouped" in Table S4.

4.3 Comparison with Marine Protected Areas

Marine reserves that exclude all fishing have been established around the world. These diverse experiments in spatial fisheries management provide another mechanism for evaluating stock status in fisheries without stock assessments. Global synthesis of the responses of species to protection from fishing (*30*) shows an average increase in biomass of more than 400%. One approach to estimating stock status from such comparisons inside and outside reserves is to use the biomass density inside the reserve to estimate the unfished biomass, B_0. The biomass per unit area in the reserve will underestimate B_0 for several reasons: inadequate reserve size (which enhances mortality when fish cross the reserve boundary), inadequate reserve enforcement, and inadequate time for fish in reserves to recover. The first two biases are difficult to correct given the absence of relevant data, but studies of long term trends in marine reserves suggest that biomass tends to increase logistically over time, often for many decades (*31*). We used these findings to forecast B_o as the asymptotic biomass inside the reserve by projecting logistic increases based on the observed rate of biomass increase for each reserve. Although the time to reach peak biomass in reserves varies greatly (*31*), we used a conservative estimate of 15 years. Therefore, for all reserves that have been in place longer than 15 years, we assumed that the biomass inside the reserve (B_R) equals B_0. For reserves younger than 15 years, we projected B_0 by assuming logistic growth at the observed rate of biomass increase with a biomass asymptote after 15 years.

Empirical and model estimates of B_{msy} as a fraction of B_0 vary among species (*32*). Based upon empirical and model estimates we used $B_{msy}= 0.4\ B_0$ as a reasonably conservative estimate for comparison with B in the fished areas outside the marine reserves. The median ratio from the 78 studies of fished species with reserves greater than 2 years of age was 0.52. Matching fisheries from the MPA database with the same regional fisheries, our corresponding estimate of the median B/B_{msy} was 0.62. The smaller estimate from the MPA data is well within the confidence limits for an estimate with 50 fisheries (see below) but may also reflect differences in the spatial scales of the estimates. The MPA estimates are far more localized than the stock level estimates at country or regional scales.

4.4 Precision of Median Estimates

Our method allows for the calculation of confidence intervals around the median of any given aggregation of fisheries, from an individual stock up to the global pool. However, the width of the 95% confidence interval around this estimate is a function of the number of fisheries included in the aggregation. For individual fisheries, the confidence interval width is approximately 1, indicating that we have very little certainty as to the value of B/B_{msy} predicted for any single fishery. To examine this in more detail, we randomly selected a set of X fisheries and estimated the median and 95% CI of the median for that group of fisheries. By drawing 1000 samples of X, and repeating this process for a range of X (from 1 to 1500), we get an estimate of the expected confidence interval width over the median for any group size (Fig. S8). As increasing numbers of fisheries are aggregated, the width of the confidence interval over the median quickly decreases, falling below 0.2 for groups of 250 fisheries or larger.

4.5 Model-by-Model Breakdown of Fisheries

Table S7 shows the number of fisheries over which each model was applied, and the median B/B_{msy} in 2009 predicted by the model for those fisheries.

4.6 Does Fishery Size Bias Results?

We questioned the extent to which fishery size (in landings) was influencing our predictions. While the PRM contains several harvest variables, most are scaled, so fishery size is irrelevant. The only variable that is influenced by fishery size is “maximum recorded catch”, whose estimated coefficient was small and statistically insignificant in all 6 models. Furthermore, this coefficient is negative, suggesting that smaller fisheries should have higher B/B_{msy}, ceteris paribus. To further test the influence of this variable, we also ran the regressions for model 1 and model 6 with and without the maximum catch variable. In both cases, removing maximum catch has almost no effect on the predictions of B/B_{msy}.

4.7 Do Reporting Errors Bias Results?

A further question concerns the effects of sporadic reporting of catch data on estimates of B/B_{msy}. We ran a series of simulations of increasing variability in harvest reporting (measured as the coefficient of variation (CV) of year-to-year landings) in order to assess whether CV systemically biases our model’s prediction of B/B_{msy}.

For each model *m*, we selected 100 random fisheries *f*. For each *f*, we retain all non-catch related model parameters. For each *f*, we simulated 100 catch histories, each based on the original catch history, with each year being multiplied by a randomly generated log normal error term with mean 0 and standard deviation σ, where σ is tested at levels of 0.25 to 1 in 0.25 size increments. For each fishery, this method provides 100 randomly generated catch histories over 4 increasing levels of variability, each of which were used together with the non-catch related regressors to calculate a new value of B/B_{msy}, as well as its associated new CV. This allows us to examine the effect of CV on B/B_{msy}, while holding non-landings related variables constant.

Aggregating across all models, there is some correlation between increased year-to-year CV and B/B_{msy} (slope=0.12, R^2=0.01, *p*=0.00; Fig. S9). This suggests that grouping across all models, high year-to-year CV has a slight positive influence on our estimate of B/B_{msy}, though the fit is extremely poor. However, when broken apart some individual models show different correlations. For example, models 1 and 2 showed some negative correlation between CV and B/B_{msy} (slope =-0.03; -0.12, p=0.45; 0.00), while model 6 has a significant positive relationship (slope=0.18, p=0.00) between the two factors.

The results of our analysis of model bias from fishery size and variable catch reporting indicate that in aggregate, variable catch records do not significantly bias B/B_{msy}, and fishery size itself has no systemic effect on B/B_{msy}. As such, we see no evidence that fisheries should be removed from the analysis purely as a function of size or high year-to-year CV. Regardless, by omitting all fisheries missing more than 10% of their catch records, our interpolation filter serves to remove many fisheries with highly variable catch data from our analysis.

4.8 Does Chronic Underreporting of Catch Bias Results?

In addition to the possibility of sporadic reporting, there is also a potential source of error introduced by chronic under-reporting of landings. In order to assess the potential bias introduced by underreporting, we tested the effect on our predictions of B/B_{msy} of multiplying the catch histories of individual fisheries by increasing levels of a constant factor. Since all catch parameters in our model except the "maximum lifetime catch" are scaled by dividing them by the maximum lifetime catch, the catch factors cancel out for all variables except the maximum lifetime catch.

For each model *m*, we selected 100 random fisheries *f*. For each *f*, we multiplied the catch by a scalar from 1 to 5, and then calculated a new prediction of B/B_{msy} using this altered parameter. Comparing these new estimates of B/B_{msy} to the estimates produced using the original catch values provides a measure of the bias introduced if catches are in fact systemically higher than those reported in our database.

Results of this simulation show that chronic under (or over) reporting of landings are unlikely to bias our results in any systemic way. Even assuming that catches are under reported by a factor of up to 5 times has no significant effect on our model's predictions of B/B_{msy} (Fig. S10).

4.9 Do Errors in Life History Variables Bias Results?

Given the need to collect life history data on a large number of species, life history data were obtained from FishBase (*15*). While this is the best source available for obtaining life history parameters for a wide number of species in an automated manner, there are known limitations to the reliability of the estimates that are obtained in this way. We ran a series of simulations to test if inaccurate life history parameters could bias our results.

For each model *m*, we selected 100 random fisheries *f*. For each *f*, we selected each of the non-catch related model parameters. For 100 iterations over each *f*, every non-catch parameter was multiplied by a randomly generated log normal error term with mean 0 and standard deviation σ, where σ is tested at levels of 0.25 to 1 in 0.25 size increments. For each fishery, this method provides a set of 100 different combinations of life history parameters over 4 increasing levels of variability, each of which were used together with the catch related regressors to calculate a new value of B/B_{msy}, as well as the associated level of error introduced to the life history parameters.

The results of our simulation show that high levels of error in our life history parameters could significantly bias our predictions in a positive direction. At low levels of σ little bias is evident in our results. However, as σ is increased, a significant positive bias is introduced. This suggests that if on the whole our life history variables are extremely inaccurate, there is a possibility that our model is under-estimating B/B_{msy} (Fig. S11).

4.10 Does Increased Variance in Unassessed Fisheries Bias Results?

In order to perform the retransformation bias correction needed to calculate median values of B/B_{msy}, we make use of the variances derived from the residuals of the stock assessed fisheries (See Section 1.2). However, it is possible that due to uncertainties in data collection the variance for the unassessed fisheries are greater than those for the stock assessed group. In order to test for the effect this possibility, we ran a series of simulations testing the influence of introducing increased variance to our retransformation bias corrected estimate of global median B/B_{msy} in 2009.

We introduced a variance augmentation factor ranging from 1 to 3. For each level of this factor, we then recalculated the median 2009 global B/B_{msy}, multiplying the variance parameters within the retransformation bias correction by the correct variance augmentation factor. The results show that increasing the amount of variance assumed to exist in the unassessed fisheries has no significant bias on our prediction of median B/B_{msy} (Fig. S12). While a slight positive trend is evident, the only substantial effect of this increased variance is to widen the confidence intervals around our estimate of the median.

5. Expanded Results

5.1 Yield Increase Calculations

Recovering a fishery from $B/B_{msy}<1$ to $B/B_{msy}=1$ will increase both biomass of fish in the ocean and sustainable yield. Estimating the yield increase from recovery to B_{msy} requires making an assumption about the current fishing mortality rate (measured as annual fishing mortality rate divided by fishing mortality to maintain MSY: U/U_{msy}). Assuming logistic growth, the steady state requires: $U/U_{msy}=2-B/B_{msy}$.

Under that model, the fishing mortality that leads to collapse (collapse is $B/B_{msy}=.2$) is $U^{collapse}/U_{msy} = 1.8$. Let $B^{current}/B_{msy}$ be the level of biomass estimated by our model. Define by U^0/U_{msy} the level of fishing morality that would be holding current biomass in steady state, i.e. $U^0/U_{msy}=2-B^{current}/B_{msy}$.

The thought experiment in the paper hypothesizes that the current level of fishing mortality (denoted $U^{current}/U_{msy}$) is somewhere between U^0/U_{msy} and $U^{collapse}/U_{msy}$. Now introduce a scaling parameter, θ, that measures the location of $U^{current}/U_{msy}$, expressed as the fractional distance between U^0/U_{msy} and $U^{collapse}/U_{msy}$, as follows:

$$\theta = \frac{\dfrac{U^{current}}{U_{msy}} - \dfrac{U^0}{U_{msy}}}{\dfrac{U^{collapse}}{U_{msy}} - \dfrac{U^0}{U_{msy}}}$$

When θ=0, fishing mortality is assumed to be at the level that would just stabilize biomass at its current level. When θ=1, fishing mortality is assumed to be at the level that would just collapse the fishery. For any given value of θ, we calculate the resulting long-term yield from continuing to fish at $U^{current}/U_{msy}$, and compare that to the long term yield from fishing at

U/U_{msy}=1. Figure 4 in the main text displays the percentage increase in yields across these two scenarios. Since B/B_{msy} has steadily declined over the three decades of our estimates, θ would be > 0 for a fishery that followed the trajectory of the median.

5.2 Trends in Species Groups over Time

Figure 1B in the main text provides a summary of B/B_{msy} values of species groups in 2009. We can also consider the trajectory of median B/B_{msy} for each of these groups over time (Fig. S13). While nearly all species groups have experienced a decline over time, individual groups have experienced very different histories of exploitation. Coastal species and large predators such as sharks show signs of being heavily depleted as early as 1975. Conversely, pelagic or benthic species such as herring or flounder were at much higher levels during that historic period, but have since seen marked declines. Shads alone show an increase over time, though our sample size for this group is very low and as such results should be interpreted with care.

5.3 Effects of National Development Level

In the main text we referred to the development status of countries. To do so, we used the Human Development Index (HDI) created by the United Nations Development Program (UNDP) in order to assess the effects of development level of nations in our database on B/B_{msy}. The HDI is a composite index of life expectancy, educational attainment, and income. Following the methods used by the UNDP, we define "developing" nations as those with an HDI < 0.7 and developed as nations with an HDI >= 0.7.

5.4 Model Estimates

The raw estimates of B/B_{msy} used in this paper are provided in Tables S8-S12. Due to the retransformation bias discussed in Section 1.2, these results cannot simply be aggregated together to develop new summary statistics without performing the required retransformation bias routine. Summary information includes time series of median B/B_{msy} for unassessed fisheries (Table S8), median B/B_{msy} in 2009 by species category (Table S9), median B/B_{msy} in 2009 by FAO region (Table S10), time series of median B/B_{msy} for small fisheries (unassessed fisheries whose lifetime landings are less than the median lifetime landings of all unassessed fisheries, calculated as 51,546 tons) (Table S11), and time series of median B/B_{msy} for large unassessed fisheries (Table S12).

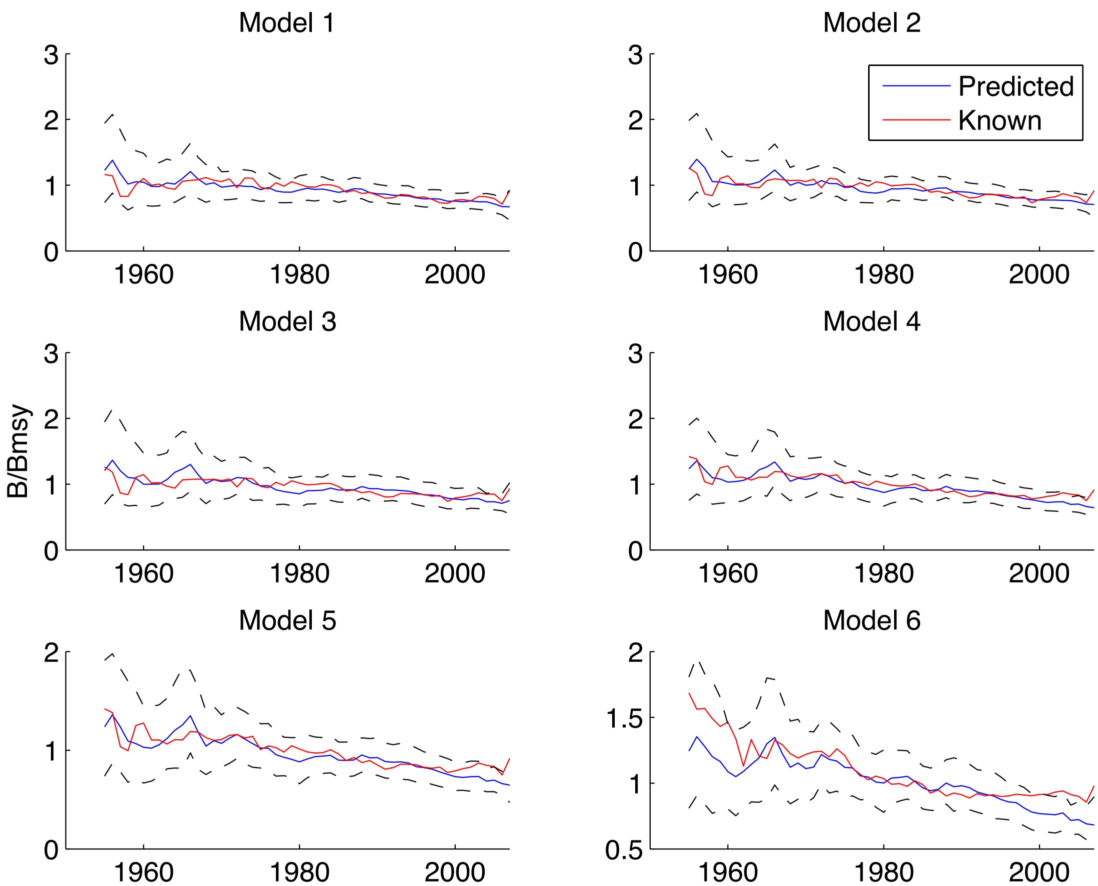

Fig. S1. Predicted vs. actual values of B/B_{msy} for stock assessed fisheries in all six models estimated using the panel regression approach. Model 1 includes all predictors. Higher numbered models successively have a reduced number of predictor variables to expand the number of fisheries with relevant data (see Table S2).

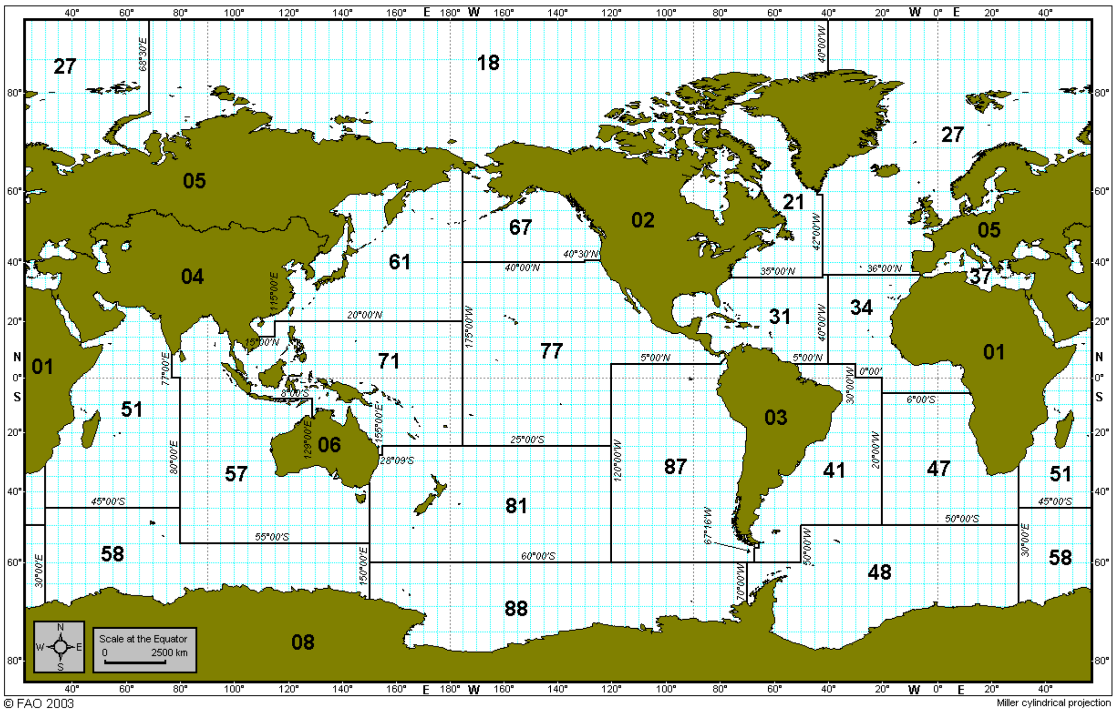

Figure S2. Map of FAO major fishery statistical region codes (available at: ftp://ftp.fao.org/fi/maps/world_2003.gif *[Accessed April 11, 2012]*).

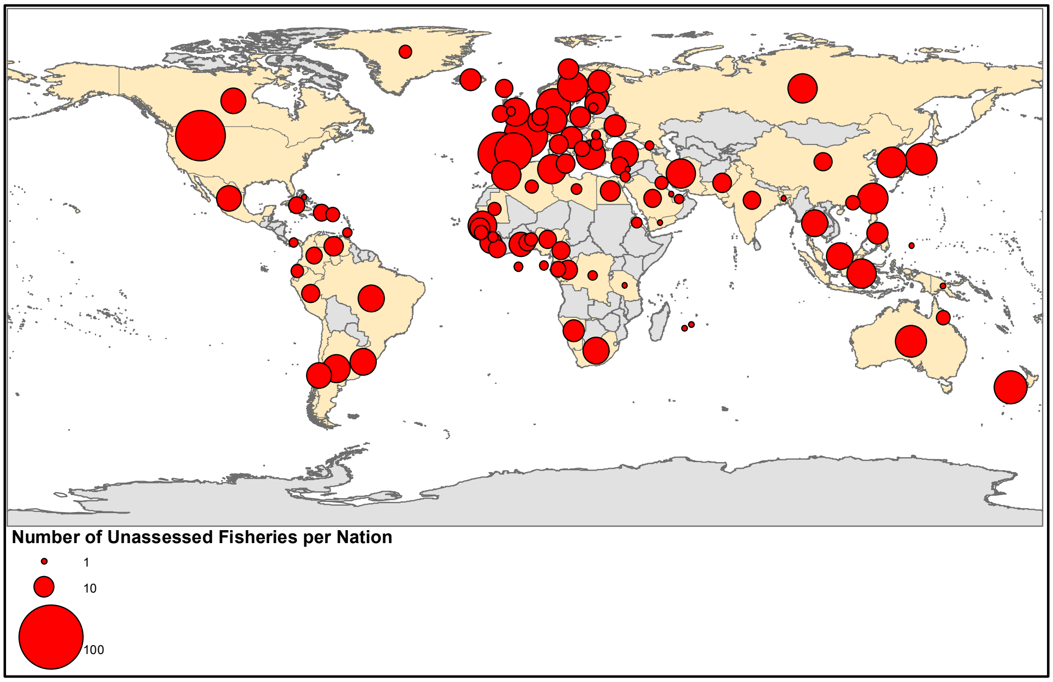

Figure S3. Number of unassessed fisheries in our database by nation. Size of bubble is scaled to the number of unassessed fisheries collected within a given nation.

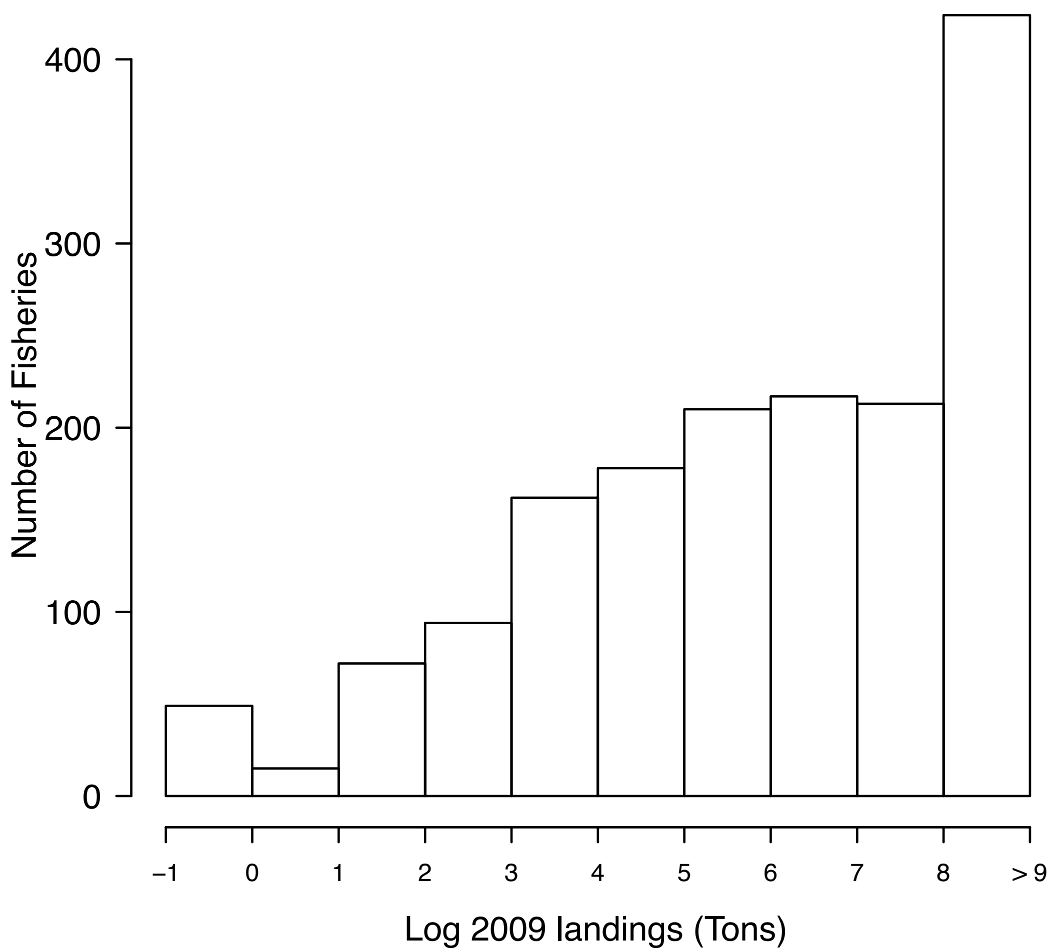

Figure S4. Histogram of log landings (tons) in 2009 among fisheries in our database.

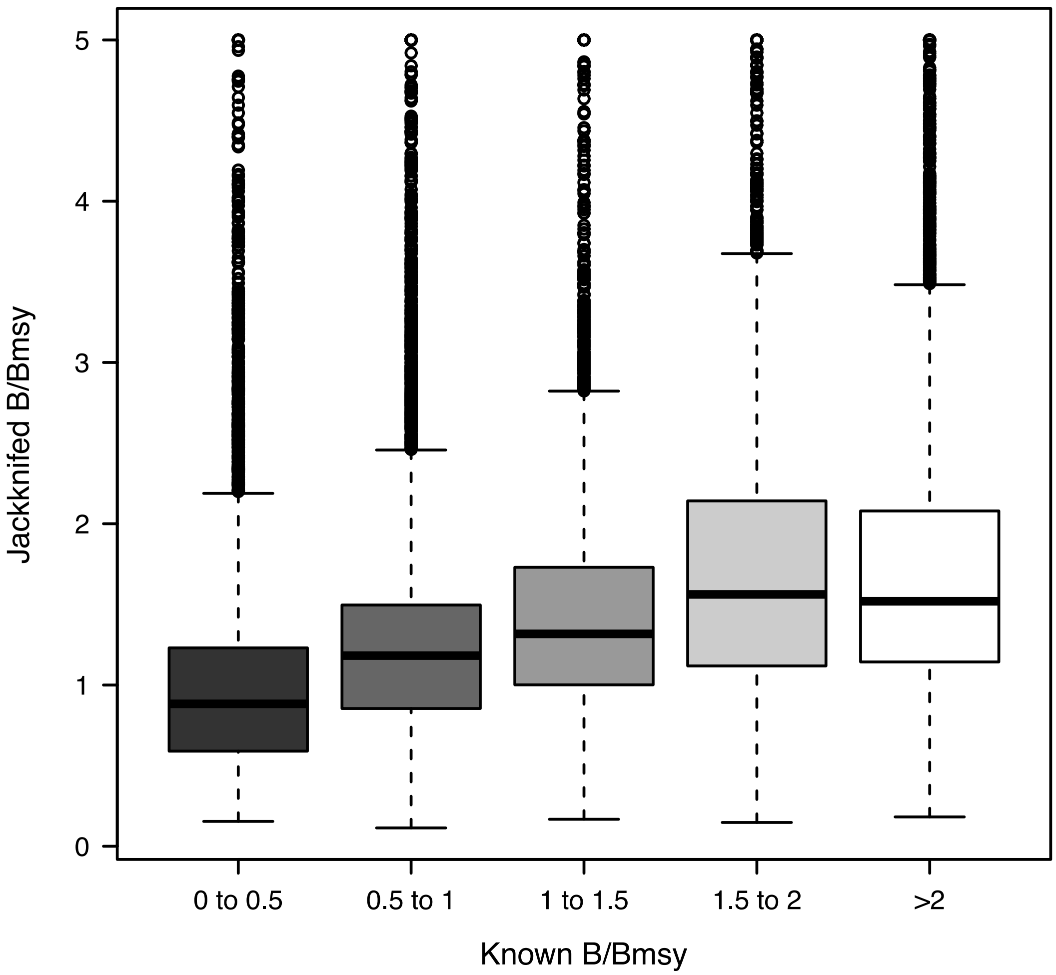

Figure S5. Jackknife analysis of regressions. The x-axis represents bins of known values of B/B_{msy}, while the y-axis shows the paired jackknifed values of B/B_{msy}.

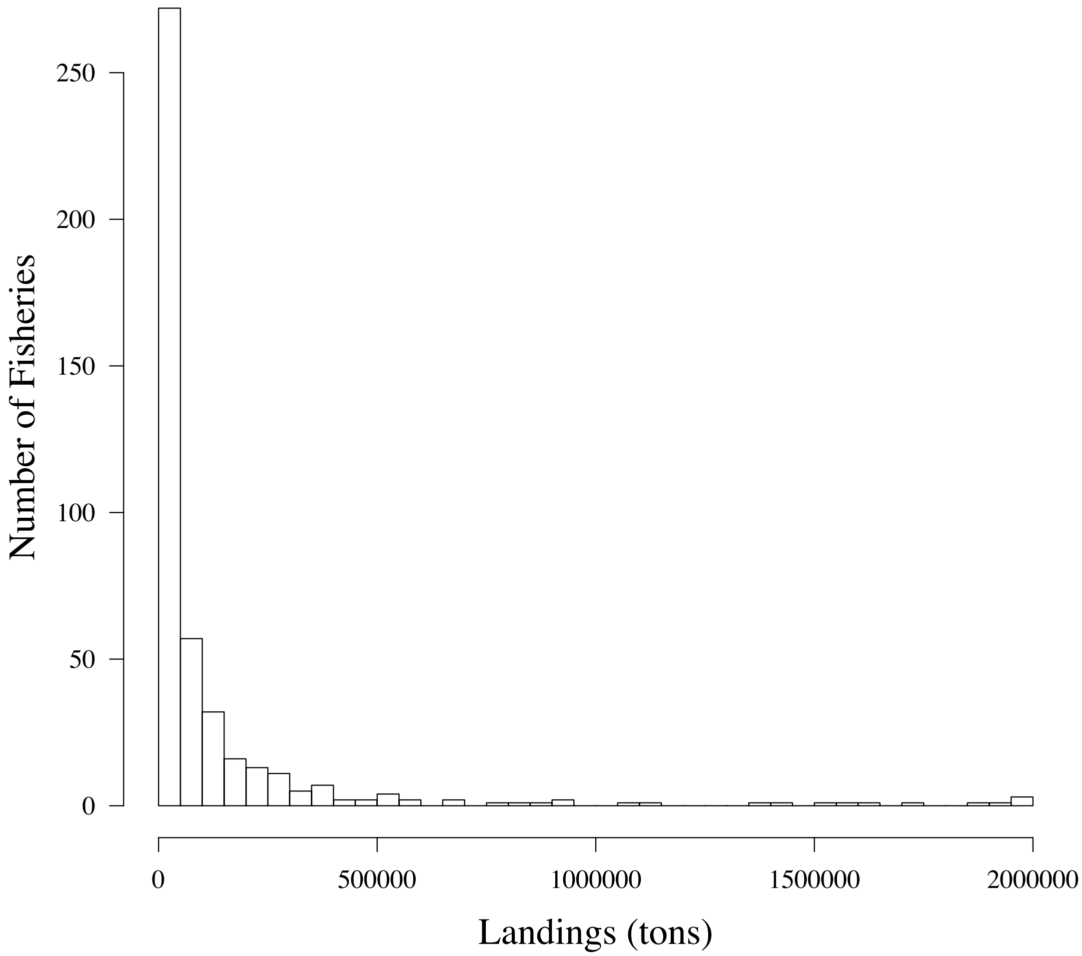

Figure S6. Histogram of landings (tons) caught in 2002 by fisheries included in FAO (*29*).

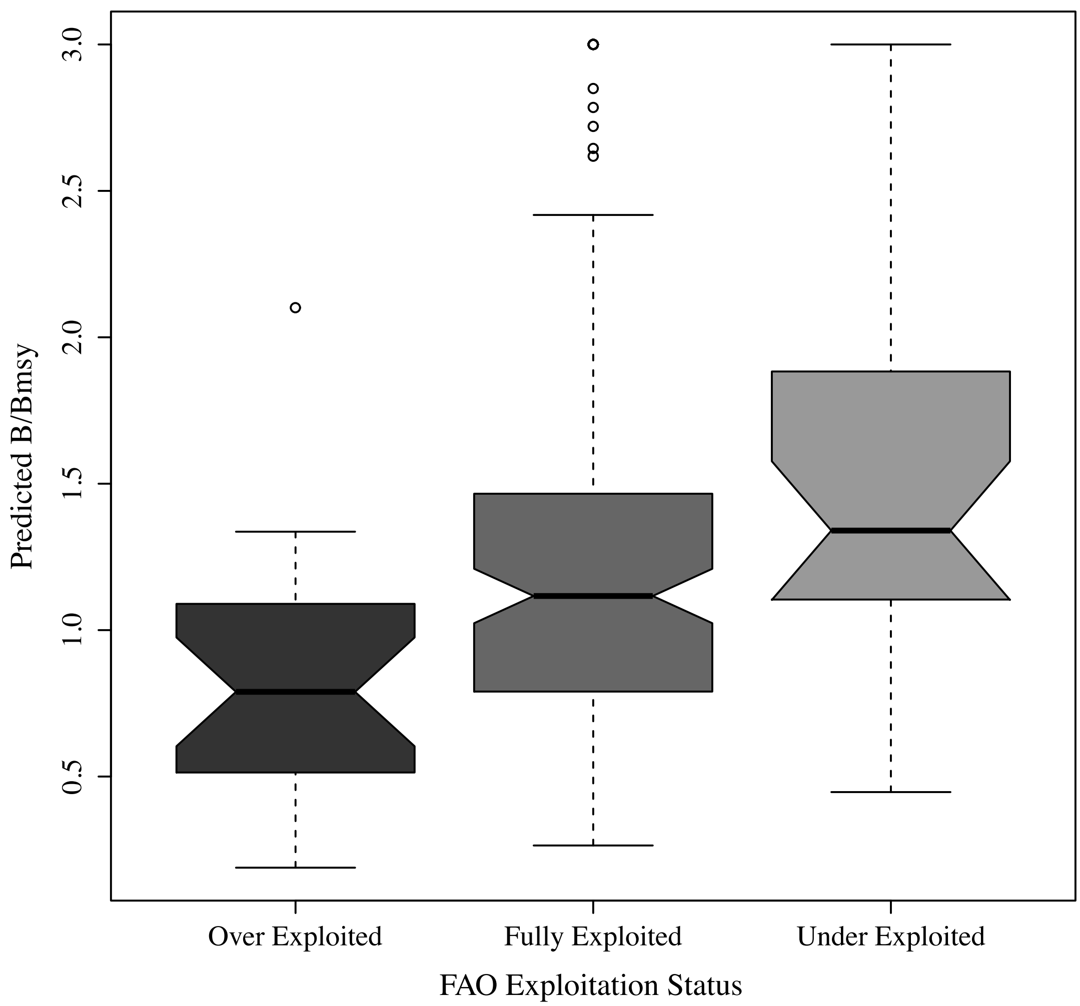

Figure S7. Box plot of model predictions of B/B_{msy} of fisheries matched to exploitation statuses defined by the FAO.

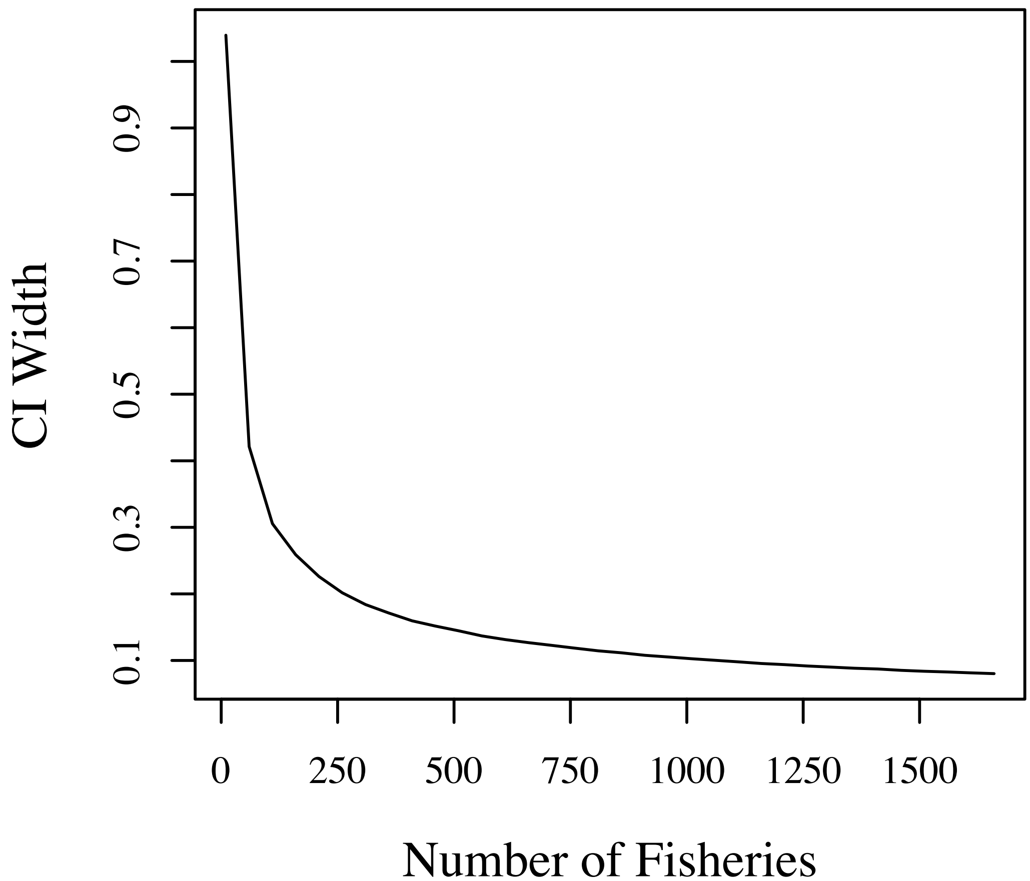

Figure S8. Width of 95% confidence intervals around the median as a function of the number of fisheries for which the median is predicted.

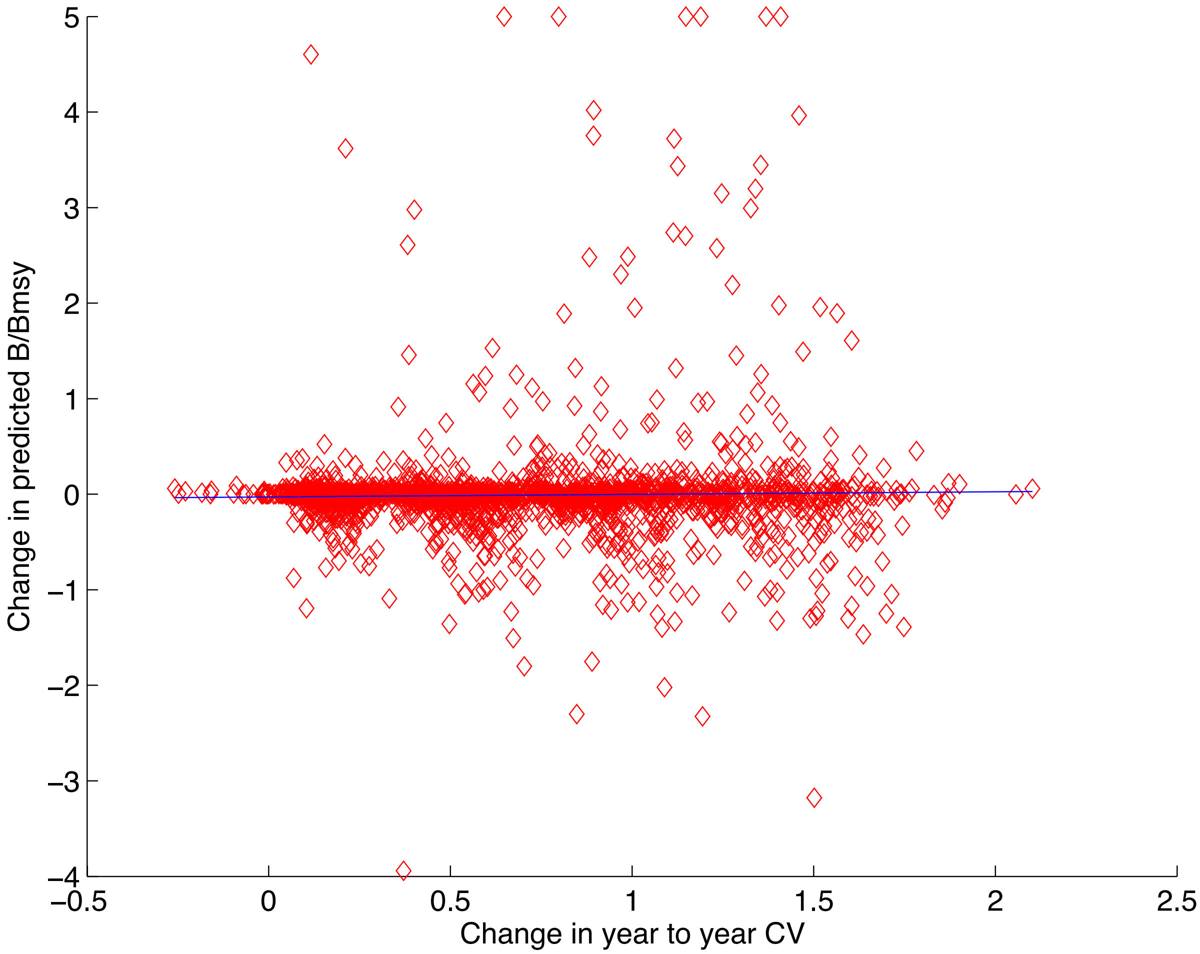

Figure S9. Effect of CV on predicted B/B$_{msy}$. Each red diamond represents the mean change in CV and B/B$_{msy}$ for one fishery over 100 simulations at a given level of introduced variance. The x-axis is the change in CV introduced to a fishery during a simulation, relative to its true CV. The y-axis is the change in B/B$_{msy}$ resulting from a change in CV, relative to the true B/B$_{msy}$. The blue line shows a linear fit to the data.

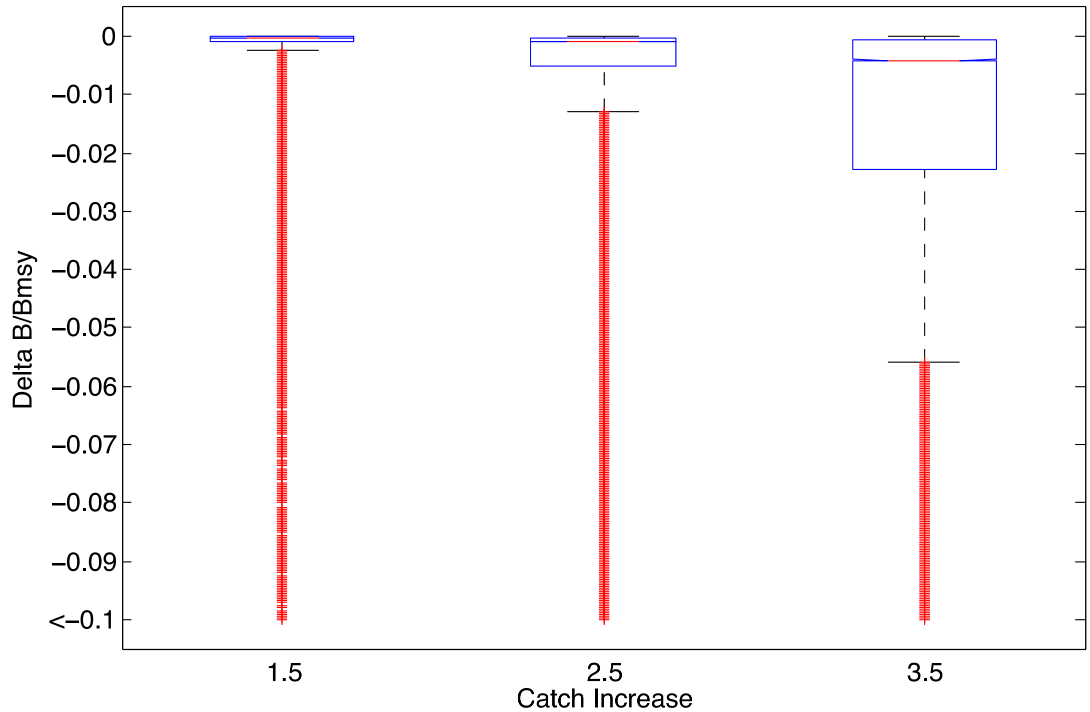

Figure S10. Change in B/B_{msy} as a result of underreporting. The y axis shows the change in B/B_{msy} predicted using catch multiplied by the catch increase factor (x axis) relative to the B/B_{msy} predicted using the original catch values.

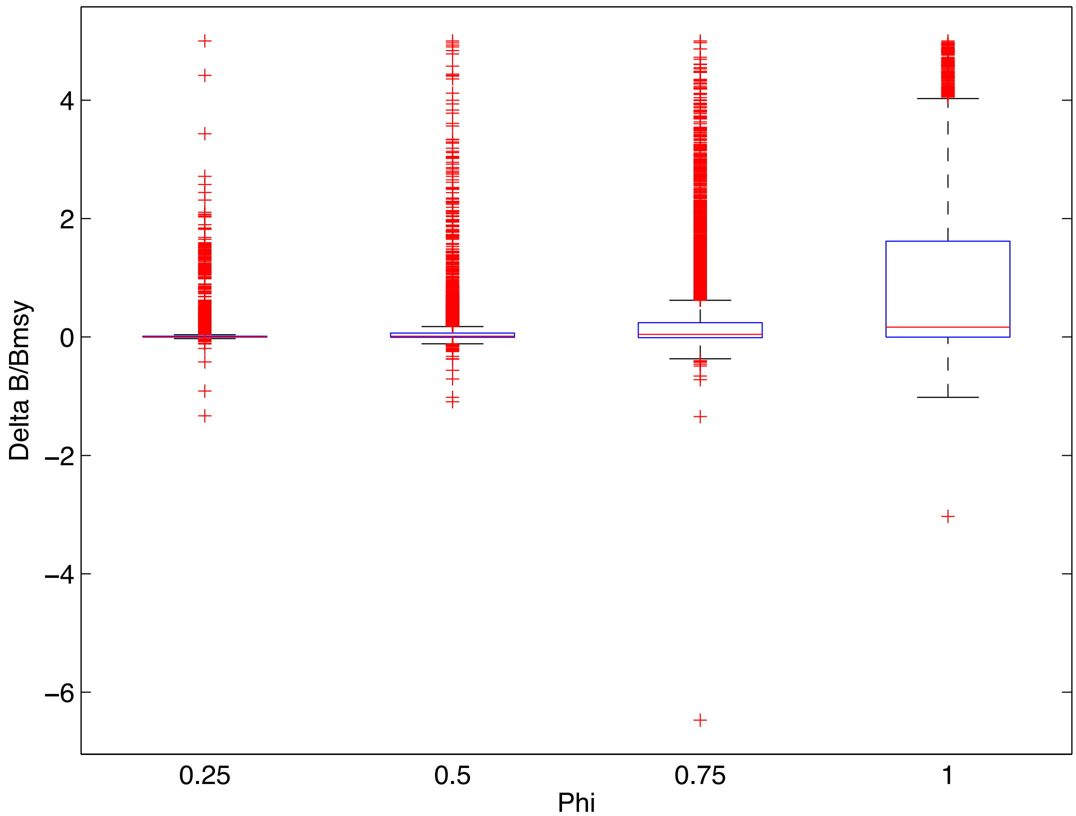

Figure S11. Change in B/B_{msy} as a function of errors in life history parameters. The y axis shows distributions of changes in B/B_{msy} predicted with life history parameters with log-normal error with standard deviation phi introduced relative to the B/B_{msy} predicted using the original life history parameters.

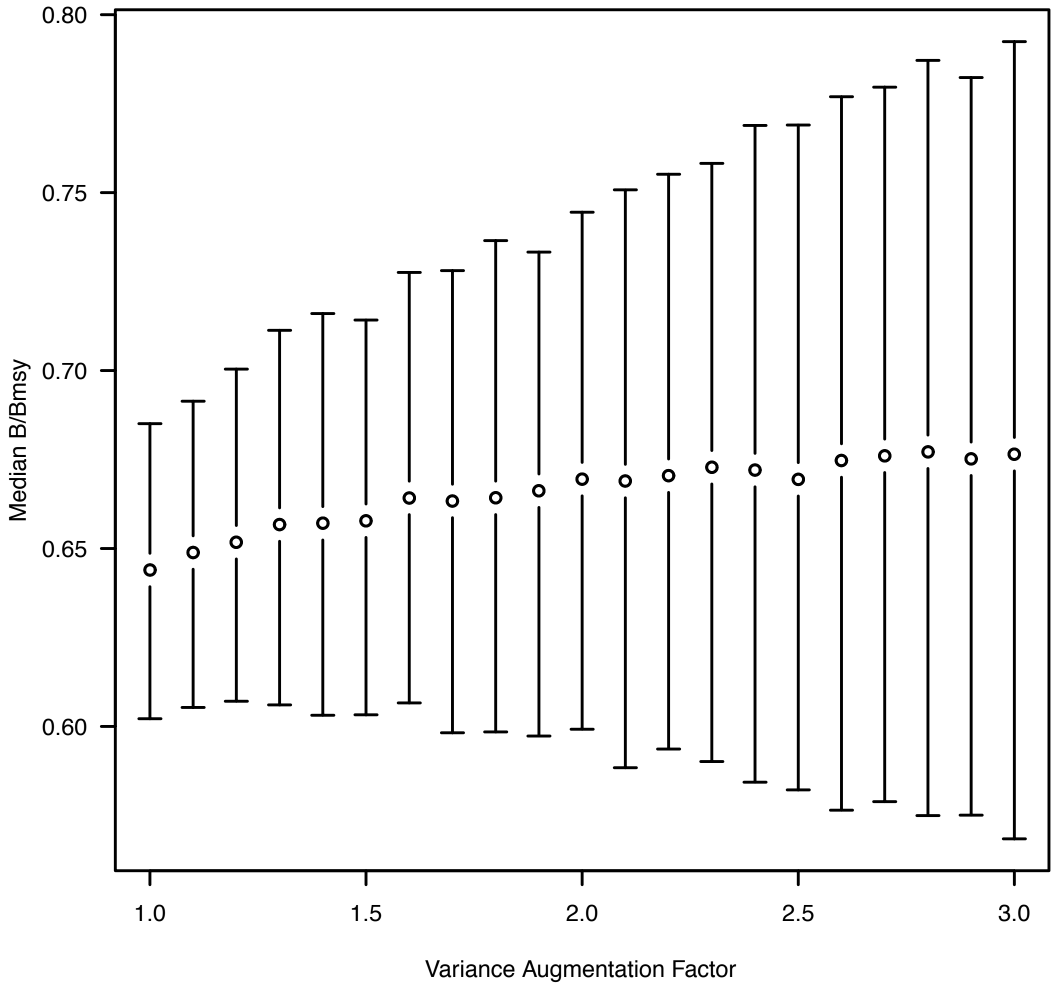

Figure S12. Change in median B/B_{msy} as a function of assumptions of increased variance in the unassessed fisheries.

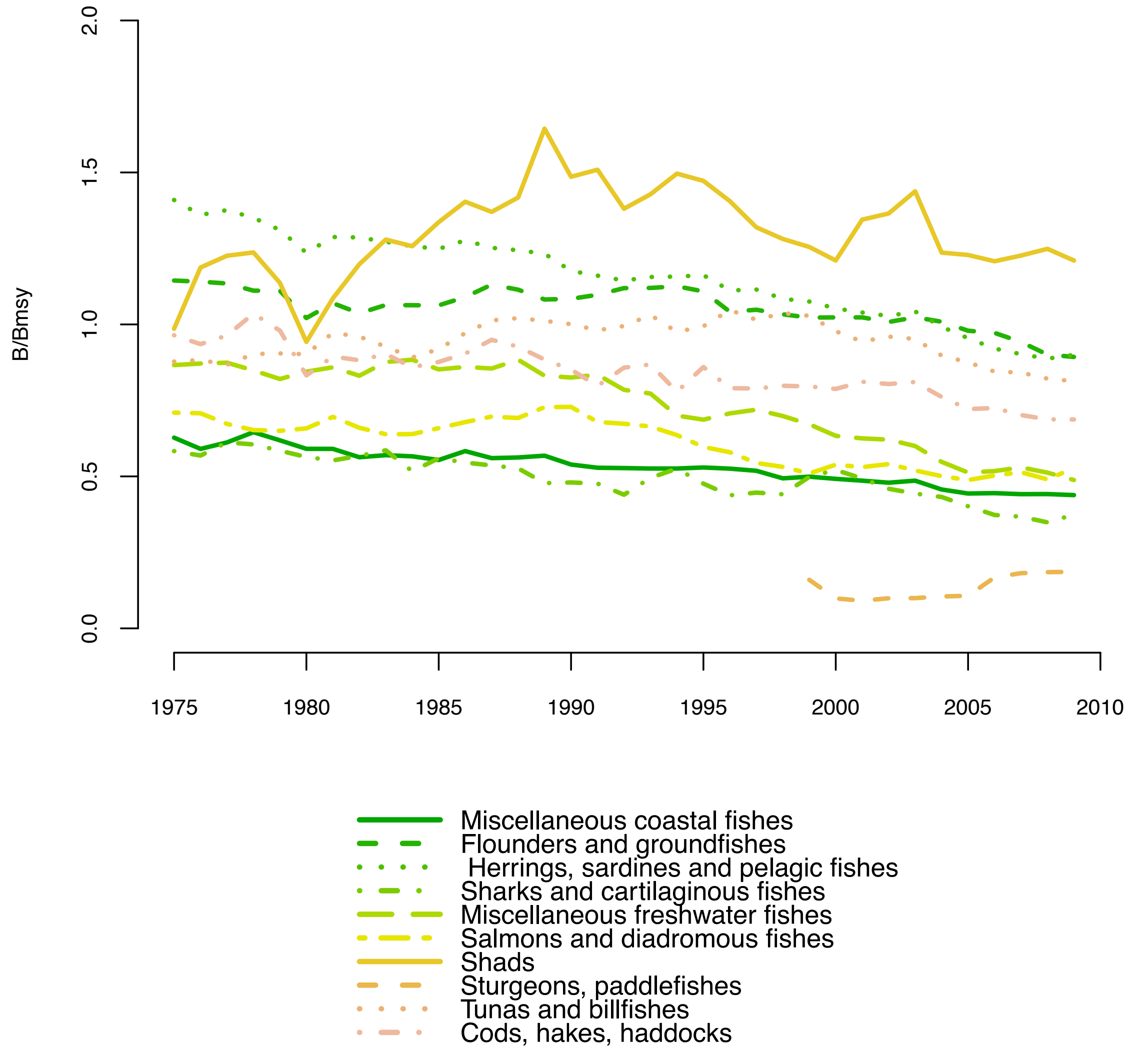

Figure S13. Median B/B_{msy} of species groups from 1975 to 2009.

Table S1. Description of variables available for inclusion in the panel regression model.

Variable	Description
Current year	Current year
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 4 years before present
Scaled harvest 3 years ago	Scaled harvest 3 years before present
Scaled harvest 2 years ago	Scaled harvest 2 years before present
Scaled harvest 1 year ago	Scaled harvest 1 year before present
Scaled harvest in 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 6 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 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
Cods hakes and haddocks	Fixed effect for the species group cods hakes and haddocks
Misc. coastal fish	Fixed effect for the species group misc. coastal fish
Misc. demersal fish	Fixed effect for the species group misc. demersal fish
Herrings, sardines, anchovies	Fixed effect for the species group herrings, sardines, anchovies
Tuna, bonito, billfish	Fixed effect for the species group tuna, bonito, billfish
Misc. pelagic fish	Fixed effect for the species group misc. pelagic fish
Constant	Constant term

Table S2. Coefficients and significance levels of variables in models 1 through 6 of the PRM. Cof indicates the variable coefficient, p>|t| indicates the significance level.

	Model											
	1		**2**		**3**		**4**		**5**		**6**	
Variable	**cof**	**p >|t|**	**cof**	**p >|t|**	**cof**	**p >|t|**	**cof**	**p >|t|**	**cof**	**p >|t|**	**cof**	**p >|t|**
Inverse age of fishery	-0.057	0.145	-0.037	0.329	0.055	0.439	0.041	0.519	0.049	0.460	0.018	0.765
Scaled harvest 4 years ago	-0.139	0.040	-0.130	0.055	-0.056	0.504	-0.096	0.193	-0.101	0.165	-0.118	0.148
Scaled harvest 3 years ago	-0.055	0.135	-0.057	0.110	0.006	0.924	-0.004	0.932	-0.003	0.952	-0.020	0.675
Scaled harvest 2 years ago	0.034	0.507	0.044	0.377	0.153	0.056	0.136	0.066	0.136	0.067	0.136	0.049
Scaled harvest 1 year ago	0.253	0.001	0.287	0.000	0.426	0.000	0.416	0.000	0.426	0.000	0.437	0.000
Scaled harvest in current year	0.255	0.310	0.137	0.598	-0.474	0.288	-0.372	0.338	-0.393	0.327	-0.475	0.174
Years to max harvest	0.011	0.025	0.011	0.010	0.007	0.340	0.008	0.240	0.007	0.288	0.005	0.371
Initial slope of harvest	-0.039	0.691	0.021	0.829	0.128	0.321	0.108	0.321	0.106	0.332	0.171	0.144
Maximum harvest	0.000	0.532	0.000	0.071	0.000	0.093	0.000	0.096	0.000	0.174	0.000	0.392
Mean scaled harvest	0.978	0.013	0.763	0.053	-0.473	0.581	-0.263	0.738	-0.357	0.669	-0.240	0.783
Von. Bert. K	0.378	0.641	0.818	0.287	1.292	0.124	0.984	0.241	NaN	NaN	NaN	NaN
Temperature	0.002	0.769	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
Geographic distribution of species	0.000	0.392	0.000	0.847	0.000	0.766	NaN	NaN	NaN	NaN	NaN	NaN
Max length	-0.003	0.035	-0.003	0.100	-0.003	0.107	-0.003	0.086	-0.003	0.024	NaN	NaN
Age at maturity	-0.025	0.108	-0.003	0.856	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
Running harvest ratio	0.705	0.000	0.794	0.000	1.231	0.000	1.165	0.000	1.184	0.000	1.167	0.000
Current year	-0.062	0.104	-0.041	0.272	0.056	0.446	0.039	0.546	0.047	0.482	0.016	0.798
Cods hakes and haddocks	0.242	0.224	0.297	0.165	0.331	0.178	0.390	0.076	0.379	0.076	0.100	0.627
Misc. coastal fish	0.124	0.557	0.153	0.437	-0.951	0.211	-0.710	0.295	-0.618	0.335	-0.476	0.301
Misc. demersal fish	1.015	0.000	0.932	0.001	0.815	0.003	0.796	0.000	0.755	0.001	0.671	0.004
Herrings, sardines, anchovies	-0.106	0.633	-0.075	0.732	-0.238	0.383	-0.102	0.713	0.058	0.770	0.093	0.706
Tuna, bonito, billfish	0.314	0.557	0.641	0.259	0.818	0.202	0.785	0.083	0.943	0.027	0.255	0.195
Misc. pelagic fish	-0.003	0.994	0.395	0.282	0.288	0.438	0.437	0.169	0.492	0.085	0.402	0.144
Constant	123.799	0.107	80.707	0.281	-112.955	0.440	-78.581	0.539	-95.563	0.477	-32.489	0.790

Table S3. Legend of FAO major fishing statistical region codes.

Marine Areas	**Zone**	**Code**
Atlantic Ocean and adjacent seas		
	Arctic Sea	18
	Atlantic, Northwest	21
	Atlantic, Northeast	27
	Atlantic, Western 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 S4. Grouping of ISSCAAP species categories. "Yes" indicates that species within that category are aggregated by FAO region, while "no" indicates that species within that category are left un-grouped.

Species Category	**Grouped (Yes,No)**
Freshwater fishes	No
Carps, barbels and other cyprinids	No
Tilapias and other cichlids	No
Miscellaneous freshwater fishes	No
Diadromous fishes	No
Sturgeons, paddlefishes	No
River eels	No
Salmons, trouts, smelts	No
Shads	No
Miscellaneous diadromous fishes	No
Marine fishes	Yes
Flounders, halibuts, soles	No
Cods, hakes, haddocks	Yes
Miscellaneous coastal fishes	No
Miscellaneous demersal fishes	No
Herrings, sardines, anchovies	No
Tunas, bonitos, billfishes	Yes
Miscellaneous pelagic fishes	Yes
Sharks, rays, chimaeras	No

Table S5. Complete list of species within our database of unassessed fisheries. The frequency column indicates the number of fisheries for each species present in the database.

Common Name	**Scientific Name**	**Frequency**
African moonfish	*Selene dorsalis*	1
African sicklefish	*Drepane africana*	10
Alaska plaice	*Pleuronectes quadrituberculat.*	1
Albacore	*Thunnus alalunga*	7
Alewife	*Alosa pseudoharengus*	3
Alexandria pompano	*Alectis alexandrinus*	1
Allis shad	*Alosa alosa*	1
Amer. plaice(=Long rough dab)	*Hippoglossoides platessoides*	5
American angler	*Lophius americanus*	1
American conger	*Conger oceanicus*	1
American eel	*Anguilla rostrata*	1
American harvestfish	*Peprilus paru*	2
American shad	*Alosa sapidissima*	3
Anchoveta(=Peruvian anchovy)	*Engraulis ringens*	1
Angelshark	*Squatina squatina*	2
Angler(=Monk)	*Lophius piscatorius*	10
Angular roughshark	*Oxynotus centrina*	2
Antarctic starry skate	*Raja georgiana*	1
Araucanian herring	*Strangomera bentincki*	1
Arctic char	*Salvelinus alpinus*	2
Argentine anchovy	*Engraulis anchoita*	1
Argentine angelshark	*Squatina argentina*	3
Argentine conger	*Conger orbignyanus*	3
Argentine croaker	*Umbrina canosai*	3
Argentine goatfish	*Mullus argentinae*	1
Argentine hake	*Merluccius hubbsi*	1
Argentine menhaden	*Brevoortia pectinata*	1
Argentine seabass	*Acanthistius brasilianus*	2
Argentines	*Argentina spp*	8
Argentinian sandperch	*Pseudopercis semifasciata*	2
Atlantic anchoveta	*Cetengraulis edentulus*	1
Atlantic bonito	*Sarda sarda*	7
Atlantic bumper	*Chloroscombrus chrysurus*	3
Atlantic butterfish	*Peprilus triacanthus*	1
Atlantic halibut	*Hippoglossus hippoglossus*	10
Atlantic horse mackerel	*Trachurus trachurus*	3
Atlantic mackerel	*Scomber scombrus*	2
Atlantic moonfish	*Selene setapinnis*	2

Atlantic pomfret	*Brama brama*	3
Atlantic sailfish	*Istiophorus albicans*	4
Atlantic salmon	*Salmo salar*	14
Atlantic saury	*Scomberesox saurus*	1
Atlantic searobins	*Prionotus spp*	2
Atlantic silverside	*Menidia menidia*	1
Atlantic Spanish mackerel	*Scomberomorus maculatus*	2
Atlantic thread herring	*Opisthonema oglinum*	6
Atlantic tomcod	*Microgadus tomcod*	1
Atlantic white marlin	*Tetrapturus albidus*	4
Atlantic wolffish	*Anarhichas lupus*	10
Australian pilchard	*Sardinops neopilchardus*	1
Australian salmon	*Arripis trutta*	2
Axillary seabream	*Pagellus acarne*	5
Baird's slickhead	*Alepocephalus bairdii*	1
Bali sardinella	*Sardinella lemuru*	2
Ballyhoo halfbeak	*Hemiramphus brasiliensis*	2
Banded yellowfish	*Centriscops humerosus*	1
Barramundi(=Giant seaperch)	*Lates calcarifer*	11
Barred grunt	*Conodon nobilis*	1
Bartail flathead	*Platycephalus indicus*	2
Basking shark	*Cetorhinus maximus*	4
Bastard halibut	*Paralichthys olivaceus*	2
Batfishes	*Platax spp*	1
Beaked redfish	*Sebastes mentella*	2
Bearded brotula	*Brotula barbata*	2
Beluga	*Huso huso*	1
Benguela hake	*Merluccius polli*	1
Big-scale sand smelt	*Atherina boyeri*	1
Bigeye croaker	*Pennahia anea*	1
Bigeye grunt	*Brachydeuterus auritus*	6
Bigeye scad	*Selar crumenophthalmus*	3
Bigeye thresher	*Alopias superciliosus*	4
Bigeye tuna	*Thunnus obesus*	3
Birdbeak dogfish	*Deania calcea*	2
Black and Caspian Sea sprat	*Clupeonella cultriventris*	2
Black cardinal fish	*Epigonus telescopus*	3
Black cusk-eel	*Genypterus maculatus*	1
Black drum	*Pogonias cromis*	5
Black marlin	*Makaira indica*	6
Black pomfret	*Parastromateus niger*	4

Black scabbardfish	*Aphanopus carbo*	6
Black seabass	*Centropristis striata*	1
Black seabream	*Spondyliosoma cantharus*	11
Black skipjack	*Euthynnus lineatus*	1
Blackbanded trevally	*Seriolina nigrofasciata*	2
Blackbelly rosefish	*Helicolenus dactylopterus*	5
Blackfin goosefish	*Lophius gastrophysus*	1
Blackfin tuna	*Thunnus atlanticus*	3
Blackhead seabream	*Acanthopagrus schlegeli*	1
Blackmouth catshark	*Galeus melastomus*	2
Blackmouth croaker	*Atrobucca nibe*	1
Blackspot(=red) seabream	*Pagellus bogaraveo*	4
Blacktip grouper	*Epinephelus fasciatus*	1
Blacktip shark	*Carcharhinus limbatus*	2
Blotched picarel	*Spicara maena*	1
Blue antimora	*Antimora rostrata*	1
Blue butterfish	*Stromateus fiatola*	1
Blue grenadier	*Macruronus novaezelandiae*	2
Blue jack mackerel	*Trachurus picturatus*	1
Blue ling	*Molva dypterygia*	1
Blue mackerel	*Scomber australasicus*	1
Blue marlin	*Makaira nigricans*	12
Blue runner	*Caranx crysos*	3
Blue shark	*Prionace glauca*	17
Blue skate	*Raja batis*	3
Blue whiting(=Poutassou)	*Micromesistius poutassou*	1
Bluefin gurnard	*Chelidonichthys kumu*	5
Bluefish	*Pomatomus saltatrix*	7
Bluenose warehou	*Hyperoglyphe antarctica*	1
Bluespot mullet	*Valamugil seheli*	2
Bluestripe herring	*Herklotsichthys quadrimaculat.*	1
Bobo croaker	*Pseudotolithus elongatus*	7
Bobo mullet	*Joturus pichardi*	2
Bocaccio rockfish	*Sebastes paucispinis*	1
Boe drum	*Pteroscion peli*	2
Bogue	*Boops boops*	22
Bombay-duck	*Harpadon nehereus*	5
Bonefish	*Albula vulpes*	3
Bonga shad	*Ethmalosa fimbriata*	10
Brazilian codling	*Urophycis brasiliensis*	1
Brazilian flathead	*Percophis brasiliensis*	2

Brazilian menhaden	*Brevoortia aurea*	2
Brazilian sardinella	*Sardinella brasiliensis*	2
Brill	*Scophthalmus rhombus*	11
Broadnose sevengill shark	*Notorynchus cepedianus*	2
Broomtail grouper	*Mycteroperca xenarcha*	1
Brown smooth-hound	*Mustelus henlei*	2
Brushtooth lizardfish	*Saurida undosquamis*	3
Burbot	*Lota lota*	4
Cabezon	*Scorpaenichthys marmoratus*	1
Cabinza grunt	*Isacia conceptionis*	2
California flounder	*Paralichthys californicus*	2
California pilchard	*Sardinops caeruleus*	3
California sheephead	*Semicossyphus pulcher*	1
Californian anchovy	*Engraulis mordax*	3
Canary drum (=Baardman)	*Umbrina canariensis*	1
Canary rockfish	*Sebastes pinniger*	1
Cape bonnetmouth	*Emmelichthys nitidus*	2
Cape elephantfish	*Callorhinchus capensis*	2
Cape hakes	*Merluccius capensis,M.paradox.*	2
Cape horse mackerel	*Trachurus capensis*	1
Capelin	*Mallotus villosus*	2
Cassava croaker	*Pseudotolithus senegalensis*	4
Castaneta	*Cheilodactylus bergi*	2
Cero	*Scomberomorus regalis*	1
Chacunda gizzard shad	*Anodontostoma chacunda*	2
Chilean silverside	*Odontesthes regia*	1
Chilipepper rockfish	*Sebastes goodei*	1
Chinese gizzard shad	*Clupanodon thrissa*	2
Chinook(=Spring=King)salmon	*Oncorhynchus tshawytscha*	5
Chocolate hind	*Cephalopholis boenak*	2
Choicy ruff	*Seriolella porosa*	1
Chola guitarfish	*Rhinobatos percellens*	2
Chub mackerel	*Scomber japonicus*	12
Chum(=Keta=Dog)salmon	*Oncorhynchus keta*	4
Cobia	*Rachycentron canadum*	7
Coho(=Silver)salmon	*Oncorhynchus kisutch*	5
Common dab	*Limanda limanda*	8
Common dentex	*Dentex dentex*	11
Common dolphinfish	*Coryphaena hippurus*	11
Common mora	*Mora moro*	1
Common pandora	*Pagellus erythrinus*	7

Common snook	*Centropomus undecimalis*	2
Common sole	*Solea solea*	21
Common warehou	*Seriolella brama*	1
Congo dentex	*Dentex congoensis*	1
Copper shark	*Carcharhinus brachyurus*	2
Corvina drum	*Cilus gilberti*	2
Crevalle jack	*Caranx hippos*	2
Crucian carp	*Carassius carassius*	1
Cuckoo ray	*Raja naevus*	2
Cunene horse mackerel	*Trachurus trecae*	2
Cunner	*Tautogolabrus adspersus*	1
Daggertooth pike conger	*Muraenesox cinereus*	8
Danube sturgeon(=Osetr)	*Acipenser gueldenstaedtii*	1
Dark ghost shark	*Hydrolagus novaezealandiae*	2
Dealfishes	*Trachipterus spp*	1
Deep-sea smelt	*Glossanodon semifasciatus*	1
Devil anglerfish	*Lophius vomerinus*	2
Dogtooth tuna	*Gymnosarda unicolor*	1
Dorab wolf-herring	*Chirocentrus dorab*	5
Dotted gizzard shad	*Konosirus punctatus*	1
Dungat grouper	*Epinephelus goreensis*	1
Dusky grouper	*Epinephelus marginatus*	5
Dusky smooth-hound	*Mustelus canis*	2
Eastern Pacific bonito	*Sarda chiliensis*	2
Eelpout	*Zoarces viviparus*	4
Eelpouts	*Lycodes spp*	1
Eeltail catfishes	*Plotosus spp*	2
Elongate ilisha	*Ilisha elongata*	1
English sole	*Pleuronectes vetulus*	2
Escolar	*Lepidocybium flavobrunneum*	5
European anchovy	*Engraulis encrasicolus*	19
European barracuda	*Sphyraena sphyraena*	1
European conger	*Conger conger*	17
European eel	*Anguilla anguilla*	18
European flounder	*Platichthys flesus*	12
European hake	*Merluccius merluccius*	2
European perch	*Perca fluviatilis*	6
European pilchard(=Sardine)	*Sardina pilchardus*	14
European seabass	*Dicentrarchus labrax*	10
European smelt	*Osmerus eperlanus*	8
European sprat	*Sprattus sprattus*	6

European whitefish	*Coregonus lavaretus*	4
False scad	*Caranx rhonchus*	1
False trevally	*Lactarius lactarius*	3
Flathead grey mullet	*Mugil cephalus*	13
Flathead sole	*Hippoglossoides elassodon*	1
Fourfinger threadfin	*Eleutheronema tetradactylum*	3
Freshwater bream	*Abramis brama*	7
Frigate and bullet tunas	*Auxis thazard, A. rochei*	11
Frigate tuna	*Auxis thazard*	1
Garfish	*Belone belone*	2
Geelbek croaker	*Atractoscion aequidens*	2
Ghost shark	*Callorhinchus milii*	4
Giant African threadfin	*Polydactylus quadrifilis*	5
Giant boarfish	*Paristiopterus labiosus*	1
Giant catfish	*Arius thalassinus*	1
Giant guitarfish	*Rhynchobatus djiddensis*	2
Giant seabass	*Stereolepis gigas*	1
Giant stargazer	*Kathetostoma giganteum*	1
Giant trevally	*Caranx ignobilis*	1
Gilthead seabream	*Sparus aurata*	9
Goatfishes	*Upeneus spp*	11
Golden redfish	*Sebastes marinus*	3
Golden threadfin bream	*Nemipterus virgatus*	1
Golden trevally	*Gnathanodon speciosus*	1
Goldstripe sardinella	*Sardinella gibbosa*	2
Great barracuda	*Sphyraena barracuda*	2
Great Northern tilefish	*Lopholatilus chamaeleonticeps*	1
Greater amberjack	*Seriola dumerili*	2
Greater forkbeard	*Phycis blennoides*	2
Greater lizardfish	*Saurida tumbil*	7
Greater weever	*Trachinus draco*	4
Greenback horse mackerel	*Trachurus declivis*	1
Greenland cod	*Gadus ogac*	1
Greenland shark	*Somniosus microcephalus*	2
Grey gurnard	*Eutrigla gurnardus*	4
Grey rockcod	*Notothenia squamifrons*	1
Grey triggerfish	*Balistes carolinensis*	2
Gulf kingcroaker	*Menticirrhus littoralis*	1
Gulf parrotfish	*Scarus persicus*	1
Gulper shark	*Centrophorus granulosus*	4
Haddock	*Melanogrammus aeglefinus*	1

Hapuku wreckfish	*Polyprion oxygeneios*	2
Hilsa shad	*Tenualosa ilisha*	4
Honnibe croaker	*Nibea mitsukurii*	1
Hound needlefish	*Tylosurus crocodilus*	1
Indian driftfish	*Ariomma indica*	1
Indian halibut	*Psettodes erumei*	7
Indian mackerel	*Rastrelliger kanagurta*	3
Indian oil sardine	*Sardinella longiceps*	5
Indian pellona	*Pellona ditchela*	3
Indian pompano	*Trachinotus mookalee*	1
Indian scad	*Decapterus russelli*	3
Indo-Pacific king mackerel	*Scomberomorus guttatus*	4
Indo-Pacific sailfish	*Istiophorus platypterus*	7
Indo-Pacific tarpon	*Megalops cyprinoides*	1
Japanese anchovy	*Engraulis japonicus*	4
Japanese flyingfish	*Cypselurus agoo*	1
Japanese halfbeak	*Hyporhamphus sajori*	1
Japanese jack mackerel	*Trachurus japonicus*	1
Japanese pilchard	*Sardinops melanostictus*	2
Japanese sandfish	*Arctoscopus japonicus*	2
Japanese sardinella	*Sardinella zunasi*	1
Japanese scad	*Decapterus maruadsi*	1
Japanese seabass	*Lateolabrax japonicus*	2
Japanese Spanish mackerel	*Scomberomorus niphonius*	1
Japanese threadfin bream	*Nemipterus japonicus*	1
Javelin grunter	*Pomadasys kaakan*	1
John dory	*Zeus faber*	14
John's snapper	*Lutjanus johnii*	1
Kamchatka flounder	*Atheresthes evermanni*	2
Kawakawa	*Euthynnus affinis*	4
Kelee shad	*Hilsa kelee*	2
King mackerel	*Scomberomorus cavalla*	3
King of herrings	*Regalecus glesne*	1
King soldier bream	*Argyrops spinifer*	2
King weakfish	*Macrodon ancylodon*	2
Kingklip	*Genypterus capensis*	1
Kitefin shark	*Dalatias licha*	4
Korean sandlance	*Hypoptychus dybowskii*	1
Ladyfish	*Elops saurus*	2
Lane snapper	*Lutjanus synagris*	5
Large yellow croaker	*Larimichthys croceus*	1

Large-eye dentex	*Dentex macrophthalmus*	4
Largeeye breams	*Gymnocranius spp*	2
Largehead hairtail	*Trichiurus lepturus*	23
Latchet(=Sharpbeak gurnard)	*Pterygotrigla polyommata*	1
Law croaker	*Pseudotolithus brachygnathus*	1
Leafscale gulper shark	*Centrophorus squamosus*	3
Leaping mullet	*Liza saliens*	1
Lebranche mullet	*Mugil liza*	1
Leerfish	*Lichia amia*	2
Lemon sole	*Microstomus kitt*	12
Leopard flounder	*Bothus pantherinus*	1
Lesser African threadfin	*Galeoides decadactylus*	11
Ling	*Molva molva*	1
Lingcod	*Ophiodon elongatus*	1
Little tunny(=Atl.black skipj)	*Euthynnus alletteratus*	6
Longbill spearfish	*Tetrapturus pfluegeri*	1
Longnosed skate	*Raja oxyrinchus*	2
Longtail tuna	*Thunnus tonggol*	3
Lumpfish(=Lumpsucker)	*Cyclopterus lumpus*	6
Madeiran sardinella	*Sardinella maderensis*	6
Malabar blood snapper	*Lutjanus malabaricus*	1
Mangrove red snapper	*Lutjanus argentimaculatus*	3
Masu(=Cherry) salmon	*Oncorhynchus masou*	1
Meagre	*Argyrosomus regius*	6
Mediterranean horse mackerel	*Trachurus mediterraneus*	1
Megrim	*Lepidorhombus whiffiagonis*	1
Milkfish	*Chanos chanos*	9
Mirror dory	*Zenopsis nebulosus*	2
Monocle breams	*Scolopsis spp*	3
Moonfish	*Mene maculata*	2
Morays	*Muraenidae*	2
Morwongs	*Nemadactylus spp*	3
Mud sole	*Austroglossus pectoralis*	1
Mutton snapper	*Lutjanus analis*	1
Narrow-barred Spanish mackerel	*Scomberomorus commerson*	5
Narrownose smooth-hound	*Mustelus schmitti*	3
Nassau grouper	*Epinephelus striatus*	3
Navaga(=Wachna cod)	*Eleginus navaga*	1
North Pacific hake	*Merluccius productus*	1
Northern kingfish	*Menticirrhus saxatilis*	1

Northern pike	*Esox lucius*	5
Northern puffer	*Sphoeroides maculatus*	1
Northern red snapper	*Lutjanus campechanus*	2
Nursehound	*Scyliorhinus stellaris*	3
Ocean whitefish	*Caulolatilus princeps*	2
Offshore silver hake	*Merluccius albidus*	1
Oilfish	*Ruvettus pretiosus*	3
Okhotsk atka mackerel	*Pleurogrammus azonus*	2
Opah	*Lampris guttatus*	3
Orange perch	*Lepidoperca pulchella*	1
Orange roughy	*Hoplostethus atlanticus*	5
Orange-spotted grouper	*Epinephelus coioides*	1
Orfe(=Ide)	*Leuciscus idus*	3
Pacific anchoveta	*Cetengraulis mysticetus*	3
Pacific angelshark	*Squatina californica*	2
Pacific bluefin tuna	*Thunnus orientalis*	6
Pacific bumper	*Chloroscombrus orqueta*	1
Pacific cod	*Gadus macrocephalus*	1
Pacific guitarfish	*Rhinobatos planiceps*	2
Pacific herring	*Clupea pallasii*	5
Pacific jack mackerel	*Trachurus symmetricus*	2
Pacific menhaden	*Ethmidium maculatum*	2
Pacific ocean perch	*Sebastes alutus*	3
Pacific pompano	*Peprilus simillimus*	1
Pacific rudderfish	*Psenopsis anomala*	3
Pacific sand sole	*Psettichthys melanostictus*	2
Pacific sandlance	*Ammodytes personatus*	1
Pacific sandperch	*Prolatilus jugularis*	1
Pacific saury	*Cololabis saira*	1
Pacific sierra	*Scomberomorus sierra*	2
Pacific thread herring	*Opisthonema libertate*	2
Panga seabream	*Pterogymnus laniarius*	2
Parona leatherjacket	*Parona signata*	1
Parore	*Girella tricuspidata*	2
Parrotfish	*Sparisoma cretense*	1
Patagonian blennie	*Eleginops maclovinus*	2
Patagonian grenadier	*Macruronus magellanicus*	2
Patagonian toothfish	*Dissostichus eleginoides*	3
Pelagic armourhead	*Pseudopentaceros richardsoni*	1
Peruvian banded croaker	*Paralonchurus peruanus*	1
Peruvian morwong	*Cheilodactylus variegatus*	2

Peruvian rock seabass	*Paralabrax humeralis*	1
Peruvian weakfish	*Cynoscion analis*	3
Picked dogfish	*Squalus acanthias*	21
Pike-perch	*Sander lucioperca*	8
Pink cusk-eel	*Genypterus blacodes*	3
Pink(=Humpback)salmon	*Oncorhynchus gorbuscha*	4
Plain bonito	*Orcynopsis unicolor*	1
Plownose chimaera	*Callorhinchus callorynchus*	5
Polar cod	*Boreogadus saida*	1
Pollack	*Pollachius pollachius*	1
Pontic shad	*Alosa pontica*	2
Ponyfishes(=Slipmouths)	*Leiognathus spp*	3
Poor cod	*Trisopterus minutus*	1
Porbeagle	*Lamna nasus*	12
Porgies	*Calamus spp*	3
Portuguese dogfish	*Centroscymnus coelolepis*	3
Pouting(=Bib)	*Trisopterus luscus*	2
Queenfishes	*Scomberoides spp*	3
Rainbow runner	*Elagatis bipinnulata*	3
Rainbow sardine	*Dussumieria acuta*	3
Rainbow smelt	*Osmerus mordax*	2
Rainbow trout	*Oncorhynchus mykiss*	2
Red bigeye	*Priacanthus macracanthus*	1
Red codling	*Pseudophycis bachus*	1
Red cusk-eel	*Genypterus chilensis*	1
Red grouper	*Epinephelus morio*	3
Red gurnard	*Aspitrigla cuculus*	1
Red hake	*Urophycis chuss*	1
Red hind	*Epinephelus guttatus*	2
Red mullet	*Mullus barbatus*	6
Red pandora	*Pagellus bellottii*	5
Red porgy	*Pagrus pagrus*	11
Red scorpionfish	*Scorpaena scrofa*	1
Red-eye round herring	*Etrumeus teres*	3
Redfish	*Centroberyx affinis*	2
Rex sole	*Glyptocephalus zachirus*	1
Ridge scaled rattail	*Macrourus carinatus*	1
Roach	*Rutilus rutilus*	7
Rock sole	*Lepidopsetta bilineata*	2
Rough scad	*Trachurus lathami*	1
Roughhead grenadier	*Macrourus berglax*	2

Round sardinella	*Sardinella aurita*	10
Roundnose grenadier	*Coryphaenoides rupestris*	2
Royal threadfin	*Pentanemus quinquarius*	4
Rubberlip grunt	*Plectorhinchus mediterraneus*	4
Rubyfish	*Plagiogeneion rubiginosum*	1
Ruff	*Arripis georgianus*	1
Sablefish	*Anoplopoma fimbria*	2
Sabre squirrelfish	*Sargocentron spiniferum*	1
Saddled seabream	*Oblada melanura*	7
Saffron cod	*Eleginus gracilis*	1
Saithe(=Pollock)	*Pollachius virens*	1
Salema	*Sarpa salpa*	9
Sand sole	*Solea lascaris*	3
Sand steenbras	*Lithognathus mormyrus*	5
Sand tiger shark	*Carcharias taurus*	2
Sandy ray	*Raja circularis*	2
Santer seabream	*Cheimerius nufar*	1
Sawfishes	*Pristidae*	4
Scaled sardines	*Harengula spp*	3
Scalloped hammerhead	*Sphyrna lewini*	2
Scamp	*Mycteroperca phenax*	1
Scats	*Scatophagus spp*	1
Sea lamprey	*Petromyzon marinus*	2
Sea trout	*Salmo trutta*	8
Senegalese hake	*Merluccius senegalensis*	1
Serra Spanish mackerel	*Scomberomorus brasiliensis*	2
Shagreen ray	*Raja fullonica*	3
Sheepshead	*Archosargus probatocephalus*	2
Shi drum	*Umbrina cirrosa*	3
Short mackerel	*Rastrelliger brachysoma*	2
Short-finned eel	*Anguilla australis*	1
Shortfin mako	*Isurus oxyrinchus*	22
Sichel	*Pelecus cultratus*	1
Silk snapper	*Lutjanus vivanus*	1
Silky shark	*Carcharhinus falciformis*	6
Sillago-whitings	*Sillaginidae*	10
Silver croaker	*Pennahia argentata*	1
Silver grunt	*Pomadasys argenteus*	1
Silver hake	*Merluccius bilinearis*	1
Silver pomfret	*Pampus argenteus*	4
Silver scabbardfish	*Lepidopus caudatus*	7

Silver seabream	*Pagrus auratus*	6
Silver warehou	*Seriolella punctata*	1
Silver-stripe round herring	*Spratelloides gracilis*	2
Silvery John dory	*Zenopsis conchifer*	2
Skipjack tuna	*Katsuwonus pelamis*	10
Small-spotted catshark	*Scyliorhinus canicula*	3
Smooth hammerhead	*Sphyrna zygaena*	4
Snoek	*Thyrsites atun*	6
Snubnose pompano	*Trachinotus blochii*	1
So-iuy mullet	*Mugil soiuy*	1
Sockeye(=Red)salmon	*Oncorhynchus nerka*	4
Sompat grunt	*Pomadasys jubelini*	4
South American pilchard	*Sardinops sagax*	3
South American silver porgy	*Diplodus argenteus*	2
South Pacific hake	*Merluccius gayi*	1
Southern African anchovy	*Engraulis capensis*	2
Southern African pilchard	*Sardinops ocellatus*	2
Southern blue whiting	*Micromesistius australis*	3
Southern bluefin tuna	*Thunnus maccoyii*	4
Southern hake	*Merluccius australis*	3
Southern meagre(=Mulloway)	*Argyrosomus hololepidotus*	5
Southern rays bream	*Brama australis*	1
Southern red snapper	*Lutjanus purpureus*	3
Spangled emperor	*Lethrinus nebulosus*	1
Splendid alfonsino	*Beryx splendens*	1
Spot croaker	*Leiostomus xanthurus*	2
Spot-tail shark	*Carcharhinus sorrah*	2
Spotfin flathead	*Grammoplites suppositus*	1
Spottail spiny turbot	*Psettodes belcheri*	1
Spotted estuary smooth-hound	*Mustelus lenticulatus*	2
Spotted gurnard	*Pterygotrigla picta*	1
Spotted ray	*Raja montagui*	2
Spotted seabass	*Dicentrarchus punctatus*	3
Spotted sicklefish	*Drepane punctata*	2
Spotted weakfish	*Cynoscion nebulosus*	2
Spotted wolffish	*Anarhichas minor*	1
Stargazer	*Uranoscopus scaber*	1
Starry ray	*Raja radiata*	2
Striped bass	*Morone saxatilis*	1
Striped bonito	*Sarda orientalis*	1
Striped marlin	*Tetrapturus audax*	7

Striped weakfish	*Cynoscion striatus*	2
Summer flounder	*Paralichthys dentatus*	1
Surf smelt	*Hypomesus pretiosus*	1
Surmullet	*Mullus surmuletus*	11
Swordfish	*Xiphias gladius*	7
Tadpole codling	*Salilota australis*	2
Talang queenfish	*Scomberoides commersonnianus*	1
Tarakihi	*Nemadactylus macropterus*	1
Tarpon	*Megalops atlanticus*	2
Tench	*Tinca tinca*	1
Thornback ray	*Raja clavata*	5
Thorntooth grenadier	*Lepidorhynchus denticulatus*	1
Threadsail filefish	*Stephanolepis cirrhifer*	1
Three-spined stickleback	*Gasterosteus aculeatus*	1
Thresher	*Alopias vulpinus*	11
Tigertooth croaker	*Otolithes ruber*	1
Toli shad	*Tenualosa toli*	2
Tonguefishes	*Cynoglossidae*	14
Tope shark	*Galeorhinus galeus*	11
Torpedo rays	*Torpedo spp*	3
Torpedo scad	*Megalaspis cordyla*	4
Tub gurnard	*Chelidonichthys lucerna*	1
Turbot	*Psetta maxima*	18
Tusk(=Cusk)	*Brosme brosme*	2
Twobar seabream	*Acanthopagrus bifasciatus*	1
Unicorn cod	*Bregmaceros mcclellandi*	2
Velvet leatherjacket	*Parika scaber*	1
Vendace	*Coregonus albula*	2
Vimba bream	*Vimba vimba*	2
Wahoo	*Acanthocybium solandri*	10
Wedge sole	*Dicologlossa cuneata*	3
West African goatfish	*Pseudupeneus prayensis*	3
West African ilisha	*Ilisha africana*	4
West African ladyfish	*Elops lacerta*	1
West African Spanish mackerel	*Scomberomorus tritor*	1
West coast sole	*Austroglossus microlepis*	2
Whip stingray	*Dasyatis akajei*	2
White croaker	*Genyonemus lineatus*	1
White grouper	*Epinephelus aeneus*	1
White hake	*Urophycis tenuis*	3
White seabream	*Diplodus sargus*	4

White steenbras	*Lithognathus lithognathus*	1
White stumpnose	*Rhabdosargus globiceps*	1
White trevally	*Pseudocaranx dentex*	1
White warehou	*Seriolella caerulea*	1
White weakfish	*Atractoscion nobilis*	1
Whitefin wolf-herring	*Chirocentrus nudus*	1
Whitehead's round herring	*Etrumeus whiteheadi*	2
Whitemouth croaker	*Micropogonias furnieri*	4
Whitespotted conger	*Conger myriaster*	1
Whiting	*Merlangius merlangus*	1
Widow rockfish	*Sebastes entomelas*	1
Winter flounder	*Pseudopleuronectes americanus*	1
Witch flounder	*Glyptocephalus cynoglossus*	12
Wreckfish	*Polyprion americanus*	6
Yellow croaker	*Larimichthys polyactis*	4
Yellow snapper	*Lutjanus argentiventris*	2
Yellow striped flounder	*Pseudopleuronectes herzenst.*	1
Yellowbar angelfish	*Pomacanthus maculosus*	1
Yellowfin seabream	*Acanthopagrus latus*	1
Yellowfin tuna	*Thunnus albacares*	8
Yellowstripe goatfish	*Mulloidichthys flavolineatus*	1
Yellowstripe scad	*Selaroides leptolepis*	3
Yellowtail amberjack	*Seriola lalandi*	2
Yellowtail rockfish	*Sebastes flavidus*	1
Yellowtail snapper	*Ocyurus chrysurus*	6

Table S6. Percentage of 2009 landings reported by the FAO accounted for by our model in each FAO region. The percentage of all landings reflects the total landings included in our model relative to the total landings reported in an FAO region. The percentage of unassessed landings reflects the total landings in our model relative to the landings reported by the FAO, excluding stock assessed fisheries.

FAO Region Number	FAO Region	% Coverage of All Landings	% Coverage of Unassessed Landings
21	Atlantic, Northwest	6%	8%
27	Atlantic, Northeast	7%	24%
31	Atlantic, Western Central	8%	13%
34	Atlantic, Eastern Central	48%	51%
37	Mediterranean and Black Sea	57%	58%
41	Atlantic, Southwest	27%	36%
47	Atlantic, Southeast	68%	71%
51	Indian Ocean, Western	33%	33%
57	Indian Ocean, Eastern	20%	21%
58	Indian Ocean, Antarctic and Southern	0%	1%
61	Pacific, Northwest	34%	37%
67	Pacific, Northeast	27%	76%
71	Pacific, Western Central	18%	21%
77	Pacific, Eastern Central	51%	58%
81	Pacific, Southwest	21%	25%
87	Pacific, Southeast	24%	57%
88	Pacific, Antarctic	0%	0%

Table S7. Breakdown of median predicted B/B_{msy} in 2009 and number of fisheries predicted by each model.

Model	**Median B/B_{msy}**	**Number of Fisheries**
1	0.36	225
2	0.70	422
3	0.93	356
4	0.62	115
5	0.67	182
6	0.57	364

Table S8. Time series of estimated B/B_{msy} for unassessed fisheries.

Year	Median B/B_{msy}	Number of Fisheries	2.5% CI	97.5% CI
1979	0.89	877	0.83	0.95
1980	0.83	905	0.76	0.90
1981	0.88	932	0.81	0.95
1982	0.86	970	0.79	0.93
1983	0.86	1007	0.80	0.92
1984	0.85	1020	0.79	0.90
1985	0.85	1050	0.79	0.91
1986	0.88	1073	0.81	0.95
1987	0.89	1098	0.83	0.96
1988	0.89	1113	0.83	0.95
1989	0.88	1142	0.81	0.94
1990	0.84	1165	0.79	0.90
1991	0.83	1196	0.78	0.90
1992	0.83	1258	0.78	0.89
1993	0.84	1276	0.79	0.90
1994	0.84	1307	0.78	0.89
1995	0.84	1327	0.78	0.90
1996	0.81	1374	0.76	0.86
1997	0.80	1395	0.75	0.86
1998	0.79	1433	0.74	0.84
1999	0.78	1484	0.73	0.83
2000	0.77	1513	0.72	0.82
2001	0.75	1583	0.71	0.80
2002	0.75	1641	0.70	0.80
2003	0.75	1705	0.70	0.79
2004	0.71	1715	0.67	0.75
2005	0.68	1712	0.64	0.71
2006	0.67	1698	0.63	0.71
2007	0.65	1678	0.61	0.69
2008	0.64	1664	0.60	0.68
2009	0.64	1634	0.61	0.69

Table S9. Median 2009 B/B_{msy} by species category.

Species Category	**Median B/B_{msy}**	**Number of Fisheries**	**2.5% CI**	**97.5% CI**
Sharks and cartilaginous fishes	0.37	112	0.28	0.48
Miscellaneous coastal fishes	0.44	436	0.39	0.49
Miscellaneous freshwater fishes	0.49	58	0.35	0.65
Salmons and diadromous fishes	0.53	76	0.39	0.69
Cods, hakes, haddocks	0.73	54	0.53	0.98
Tunas and billfishes	0.80	149	0.66	0.97
Herrings, sardines and pelagic fishes	0.81	358	0.71	0.91
Flounders and groundfishes	0.90	359	0.80	1.01
Shads	1.19	31	0.74	1.75

Table S10. Median 2009 B/B_{msy} by FAO region.

FAO Region Number	**FAO Region**	**Median B/B_{msy}**	**Number of Fisheries**	**2.5% CI**	**97.5% CI**
21	Atlantic, Northwest	0.53	58	0.38	0.76
27	Atlantic, Northeast	0.58	362	0.50	0.66
31	Atlantic, Western Central	0.50	80	0.37	0.66
34	Atlantic, Eastern Central	0.64	165	0.53	0.77
37	Mediterranean and Black Sea	0.58	223	0.49	0.69
41	Atlantic, Southwest	0.73	101	0.57	0.92
47	Atlantic, Southeast	0.63	43	0.42	0.89
51	Indian Ocean, Western	0.83	99	0.64	1.05
57	Indian Ocean, Eastern	1.20	77	0.92	1.57
58	Indian Ocean, Antarctic and Southern	1.03	2	0.18	3.47
61	Pacific, Northwest	0.72	112	0.56	0.90
67	Pacific, Northeast	0.56	33	0.35	0.85
71	Pacific, Western Central	0.97	76	0.72	1.29
77	Pacific, Eastern Central	0.43	50	0.29	0.63
81	Pacific, Southwest	0.72	91	0.53	0.94
87	Pacific, Southeast	0.62	61	0.43	0.85
88	Pacific, Antarctic	0.99	1	0.09	4.12

Table S11. Time series of median B/B_{msy} for small unassessed fisheries.

Year	Median B/B_{msy}	Number of Fisheries	2.5% CI	97.5% CI
1979	0.71	393	0.64	0.80
1980	0.68	407	0.61	0.79
1981	0.72	424	0.66	0.82
1982	0.70	455	0.64	0.79
1983	0.71	482	0.65	0.80
1984	0.69	488	0.63	0.79
1985	0.67	503	0.62	0.76
1986	0.71	520	0.65	0.81
1987	0.72	542	0.67	0.83
1988	0.72	559	0.67	0.82
1989	0.72	583	0.66	0.81
1990	0.71	604	0.64	0.79
1991	0.70	626	0.65	0.79
1992	0.70	667	0.64	0.78
1993	0.70	685	0.64	0.78
1994	0.70	703	0.64	0.79
1995	0.68	728	0.63	0.76
1996	0.66	769	0.61	0.73
1997	0.65	790	0.62	0.73
1998	0.64	825	0.60	0.72
1999	0.65	870	0.60	0.73
2000	0.65	901	0.61	0.72
2001	0.64	964	0.60	0.71
2002	0.63	1021	0.59	0.70
2003	0.63	1084	0.60	0.70
2004	0.60	1096	0.57	0.66
2005	0.57	1094	0.55	0.63
2006	0.57	1080	0.54	0.62
2007	0.55	1072	0.52	0.61
2008	0.54	1060	0.51	0.59
2009	0.55	1033	0.51	0.60

Table S12. Time series of median B/B_{msy} for large unassessed fisheries.

Year	Median B/B_{msy}	Number of Fisheries	2.5% CI	97.5% CI
1979	1.05	525	1.00	1.19
1980	0.97	540	0.89	1.12
1981	1.01	550	0.95	1.15
1982	1.01	557	0.94	1.14
1983	1.02	567	0.95	1.14
1984	1.00	574	0.93	1.13
1985	1.03	590	0.96	1.14
1986	1.05	598	0.98	1.17
1987	1.06	601	0.99	1.19
1988	1.07	598	1.00	1.20
1989	1.05	603	0.98	1.17
1990	1.00	605	0.94	1.13
1991	0.99	615	0.92	1.12
1992	1.00	635	0.93	1.11
1993	1.02	637	0.95	1.14
1994	1.01	650	0.95	1.13
1995	1.04	649	0.97	1.16
1996	1.00	655	0.95	1.13
1997	1.00	656	0.94	1.11
1998	1.00	661	0.93	1.11
1999	0.98	669	0.91	1.08
2000	0.95	668	0.90	1.06
2001	0.94	676	0.88	1.05
2002	0.94	677	0.88	1.04
2003	0.95	680	0.89	1.06
2004	0.90	680	0.85	1.00
2005	0.88	679	0.82	0.97
2006	0.86	679	0.80	0.95
2007	0.85	667	0.79	0.94
2008	0.84	665	0.78	0.94
2009	0.83	661	0.77	0.92

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