

# Database contents for the Abstract, Results and Tables of the Fish and Fisheries paper June 2011 resubmission

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## **Abstract**

Comparative analyses can provide novel insight into marine population dynamics and the status of fished species, but the world's main stock assessment database (the Myers Stock-Recruitment database) is now outdated. To facilitate new analyses, we developed a new stock assessment database, the RAM Legacy database, for commercially exploited marine fishes and invertebrates. Time series of total biomass, spawner biomass, recruits, fishing mortality, and catch form the core of the database. Assessments were assembled from 21 national and international management agencies for a total of 331 stocks (295 fish stocks representing 46 families, and 36 invertebrate stocks representing 12 families), including 9 of the world's 10 largest fisheries. Stock assessments were available from 27 Large Marine Ecosystems and 4 High Seas regions, and include the Atlantic, Pacific, Indian, Arctic and Antarctic Oceans. Most assessments came from the U.S., Europe, Canada, New Zealand, and Australia. Assessed marine stocks represent a small proportion of harvested fish taxa (18%), and an even smaller proportion of marine fish biodiversity (1%), but provide high quality abundance data for these intensively studied stocks. The database provides new insight into the status of exploited populations: 58% of stocks with reference points ( $n=214$ ) were estimated to be below the biomass that results in maximum sustainable yield ( ), and 30% had exploitation levels estimated to be above the exploitation rate that results in maximum sustainable yield ( ). We anticipate that the database will facilitate new research in population and fishery dynamics and life histories and encourage further data contributions from stock assessment scientists.

## Results

### *Summary*

Total number of proper stocks assessments: 331, from 295 marine fish populations and 36 invertebrate populations.

### *Taxonomy*

Number of species in FishBase: 12339 (from 54 orders)

Number of species in SAUP: 925 (from 36 orders)

Number of species in RAM Legacy: 163 (from 58 families and 20 orders)

RAM Legacy contains 18% of SAUP and 1% of FishBase species

Top 5 taxonomic orders in RAM Legacy: Gadiformes (n=70), Perciformes (n=65), Pleuronectiformes (n=53), Scorpaeniformes (n=41), Clupeiformes (n=36)

### *Timespan*

Number of assessments with catch timeseries: 313.

Number of assessments with recruitment timeseries: 274.

Number of assessments with spawning stock biomass timeseries: 280.

Together these comprise time series of catch/landings for 313 stocks (95%), SSB estimates for 280 stocks (85%), and recruitment estimates for 274 stocks (83%).

The median lengths of catch/landings, SSB, and recruitment timeseries were 39, 34, and 33 years, respectively. The time period covered by 90% of assessments is: catch/landings (1966-2007), SSB (1972-2007), recruitment (1971-2006), while that covered by 50% of assessments is: catch/landings (1983-2004), SSB (1985-2005), recruitment (1984-2003)

### *Assessment methodologies and reference points*

The three most common assessment methods were Statistical catch-at-age/length models (n=168), Virtual Population Analyses (n=92) and Biomass dynamics model (n=46).

Regionally, Virtual Population Analysis (VPA) is still the most common assessment model for European stocks (71% of 63 assessments), Canada (56% of 26 assessments) and Argentina (83% of 6 assessments), whereas statistical catch-at-age and -length models are more common for the United States (67% of 138 assessments), Australia (82% of 17 assessments) and New Zealand (76% of 29 assessments).

Biomass- or exploitation-based reference points were available for 262 (81%) and 224 (69%) assessments, respectively.

### *Stock status*

MSY-related reference points were available for 110 stocks (3 invertebrates) and estimated for 104 additional stocks (15 invertebrates), for a total of 214 stocks.

Of the 214 stocks presented in the fried egg, 110 and 104 of the biomass reference points and 82 and 132 of the exploitation reference points come from assessments and from surplus production model fits, respectively.

To identify potential biases arising from using BRPs derived from surplus production models we computed a contingency table of status classification for stocks that have both assessment- and Schaefer-derived BRPs (Table S2). Surplus production models correctly classified ratios of current biomass to BRPs in 76% of cases (for 58 of 76 assessments) and 64% of cases for exploitation BRPs (for 28 of 44 assessments).

Overall, 58% of stocks are estimated to be below their biomass-related MSY BRP, that is  $B_{curr} < B_{msy}$ , and 30% are estimated to be above their exploitation-related MSY BRP,  $U_{curr} > U_{msy}$  (n=214 stocks total. Of the stocks for which biomass is currently estimated to be below  $B_{msy}$ , 55% have had their exploitation rate reduced below  $U_{msy}$ , suggesting potential for recovery. The remaining 45% of these stocks however, still have excessive exploitation rates. On a positive note, 42% of all stocks are estimated to be above  $B_{msy}$ , and 91% of the stocks above  $B_{msy}$  also have  $U_{current}$  below  $U_{msy}$ .

## *Global fisheries*

### *Management bodies and geography*

Number of assessments from NMFS: 138 (80 with reference points, 40 (50 %) are below  $B_{msy}$ , 63 (79 %) are below  $U_{msy}$ , )

Number of assessments from ICES: 63 (48 with reference points, 39 (81 %) are below  $B_{msy}$ , 22 (46 %) are below  $U_{msy}$ , )

Number of assessments from ICES: 63 (23 with  $B_{lim}$  and  $F_{lim}$  reference points, 7 are below  $B_{lim}$  and above  $F_{lim}$ , 1 are above  $B_{lim}$  and above  $F_{lim}$ , 11 are above  $B_{lim}$  and below  $F_{lim}$  and 4 are below  $B_{msy}$  and below  $F_{lim}$ .

Number of assessments from MFish: 29 (28 with reference points, 11 (39 %) are below  $B_{msy}$ , 22 (79 %) are below  $U_{msy}$ , )

Number of assessments from DFO: 26 (14 with reference points, 12 (86 %) are below  $B_{msy}$ , 13 (93 %) are below  $U_{msy}$ , )

Number of assessments from AFMA: 17 (11 with reference points, 7 (64 %) are below  $B_{msy}$ , 7 (64 %) are below  $U_{msy}$ , )

Number of assessments from DETMCM: 14 (6 with reference points, 3 (50 %) are below  $B_{msy}$ , 5 (83 %) are below  $U_{msy}$ , )

The status of exploited marine stocks, as estimated from biomass- and exploitation-BRPs, varied widely depending on the management body. Most European stocks (managed by ICES) have biomasses less than  $B_{msy}$  (81%), and over half of these stocks (59%) still have exploitation rates exceeding  $U_{msy}$ . Canadian stocks (managed by DFO) also had low biomass (86% <  $B_{msy}$ ), but all but one of these has had its exploitation rate reduced below  $U_{msy}$ . In contrast, about half (50%) of U.S. stocks (managed by NMFS) are estimated to still be above  $B_{msy}$ , and of the 40 stocks that are below  $B_{msy}$  65% have exploitation rates below  $U_{msy}$ . In the New Zealand and Australian waters, stocks managed by MFish and AFMA are above  $B_{msy}$  in 61% and 36% of cases, respectively.

For the stocks grouped as “Atlantic” in the fried eggs we found that 6 of the 10 ICCAT stocks and 6 of the 10 of NAFO stocks were below  $B_{msy}$  .

Assessments were available for 27 LMEs, with the greatest number of assessed stocks coming from Northeast U.S. Continental Shelf (n=59), California Current (n=35), New Zealand Shelf (n=29), Gulf of Alaska (n=27), Celtic-Biscay Shelf (n=26), East Bering Sea (n=21) and Southeast U.S. Continental Shelf (n=20).

The proportion of stocks below  $B_{msy}$  and below  $U_{mys}$  varies considerably by management body.

ICES has 48 assessments in Table 4, 39 (81%) of which are below  $B_{msy}$  and 22 are below  $U_{msy}$ .

#### *Stock status by taxonomic orders*

Of the 48 stocks for Gadiformes, 15 are below  $B_{msy}$  and above  $U_{msy}$ , 2 are above  $B_{msy}$  and above  $U_{msy}$ , 9 are above  $B_{msy}$  and below  $U_{msy}$  and 22 are below  $B_{msy}$  and below  $U_{msy}$ .

Of the 45 stocks for Perciformes, 13 are below  $B_{msy}$  and above  $U_{msy}$ , 1 are above  $B_{msy}$  and above  $U_{msy}$ , 17 are above  $B_{msy}$  and below  $U_{msy}$  and 14 are below  $B_{msy}$  and below  $U_{msy}$ .

Of the 38 stocks for Pleuronectiformes, 14 are below  $B_{msy}$  and above  $U_{msy}$ , 1 are above  $B_{msy}$  and above  $U_{msy}$ , 18 are above  $B_{msy}$  and below  $U_{msy}$  and 5 are below  $B_{msy}$  and below  $U_{msy}$ .

Of the 25 stocks for Scorpaeniformes, 2 are below  $B_{msy}$  and above  $U_{msy}$ , 1 are above  $B_{msy}$  and above  $U_{msy}$ , 14 are above  $B_{msy}$  and below  $U_{msy}$  and 8 are below  $B_{msy}$  and below  $U_{msy}$ .

Of the 23 stocks for Clupeiformes, 4 are below  $B_{msy}$  and above  $U_{msy}$ , 2 are above  $B_{msy}$  and above  $U_{msy}$ , 7 are above  $B_{msy}$  and below  $U_{msy}$  and 10 are below  $B_{msy}$  and below  $U_{msy}$ .

Of the 12 stocks for Decapoda, 5 are below  $B_{msy}$  and above  $U_{msy}$ , 1 are above  $B_{msy}$  and above  $U_{msy}$ , 2 are above  $B_{msy}$  and below  $U_{msy}$  and 4 are below  $B_{msy}$  and below

$U_{msy}$ .

#### *Stock status by Mean Trophic Level*

Of the 26 stocks of MTL between 2 and 3 , 10 are below  $B_{msy}$  and above  $U_{msy}$ , 1 are above  $B_{msy}$  and above  $U_{msy}$ , 7 are above  $B_{msy}$  and below  $U_{msy}$  and 8 are below  $B_{msy}$  and below  $U_{msy}$ .

Of the 94 stocks of MTL between 3 and 4 , 19 are below  $B_{msy}$  and above  $U_{msy}$ , 3 are above  $B_{msy}$  and above  $U_{msy}$ , 38 are above  $B_{msy}$  and below  $U_{msy}$  and 34 are below  $B_{msy}$  and below  $U_{msy}$ .

Of the 89 stocks of MTL above 4 , 25 are below  $B_{msy}$  and above  $U_{msy}$ , 4 are above  $B_{msy}$  and above  $U_{msy}$ , 34 are above  $B_{msy}$  and below  $U_{msy}$  and 26 are below  $B_{msy}$  and below  $U_{msy}$ .

#### *Stock status by Functional Grouping*

Of the 146 demersal stocks, 39 are below  $B_{msy}$  and above  $U_{msy}$ , 4 are above  $B_{msy}$  and above  $U_{msy}$ , 58 are above  $B_{msy}$  and below  $U_{msy}$  and 45 are below  $B_{msy}$  and below  $U_{msy}$ .

Of the 49 pelagic stocks, 10 are below  $B_{msy}$  and above  $U_{msy}$ , 3 are above  $B_{msy}$  and above  $U_{msy}$ , 18 are above  $B_{msy}$  and below  $U_{msy}$  and 18 are below  $B_{msy}$  and below  $U_{msy}$ .

Of the 18 invertebrates stocks, 7 are below  $B_{msy}$  and above  $U_{msy}$ , 1 are above  $B_{msy}$  and above  $U_{msy}$ , 4 are above  $B_{msy}$  and below  $U_{msy}$  and 6 are below  $B_{msy}$  and below  $U_{msy}$ .

#### **Tables**

Table 1: Number of assessments included in the RAM Legacy database

<i>Country/Ocean</i>	<i>Management Body</i>	<i>Acronym</i>	<i>No. stocks</i>
USA	National Marine Fisheries Service	NMFS	138
Multinational	International Council for the Exploration of the Sea	ICES	63
New Zealand	Ministry of Fisheries	MFish	29
Canada	Department of Fisheries and Oceans	DFO	26
Australia	Australian Fisheries Management Authority	AFMA	17
South Africa	South African national management	DETMCM	14
Multinational	International Commission for the Conservation of Atlantic Tunas	ICCAT	10
Multinational	Northwest Atlantic Fisheries Organization	NAFO	8
Argentina	Consejo Federal Pesquero	CFP	6
Multinational	Western and Central Pacific Fisheries Commission	WCPFC	5
USA	US state-level management	US State	3
Multinational	Inter-American Tropical Tuna Commission	IATTC	2
Russia	Russian Federal Fisheries Agency	RFFA	2
Multinational	Commission for the Conservation of Antarctic Marine Living Resources	CCAMLR	1
Multinational	Commission for the Conservation of Southern Bluefin Tuna	CCSBT	1
Russia	Institute of Marine Biology	IMBIO	1