

Supplementary Material

Table S1. Number of stocks used for analysis.

Criterion	Number of Stocks	Number of Assessments
All RAMLDB stocks	1,330 (412 U.S., 208 Europe, 250 Canada, 88 Japan, 372 elsewhere)	2,163
Stocks with at-least two assessments	449 (88 U.S., 167 Europe, 31 Canada, 15 Japan, 148 elsewhere)	1,284
Stocks with biomass and fishing mortality estimates	263 (72 U.S., 60 Europe, 18 Canada, 14 Japan, 99 elsewhere)	804
Extra stocks (14) in the U.S South Atlantic from SouthEast Data, Assessment, and Review (SEDAR) Stock Assessment Program (http://sedarweb.org/sedar-projects)	277 (86 U.S., 60 Europe, 18 Canada, 14 Japan, 99 elsewhere)	838

Table S2. Prior distributions for the estimated parameters. Gamma (a, b) represents a gamma prior with shape parameter = a and rate parameter = b.

Parameter	Prior	
$\mu_{i,ty}$	B_{ty}	Uniform (0, 25)
	B_{MSY}	Uniform (0, 25)
	B_{ty}/B_{MSY}	Uniform (-5, 5)
	F_{ty}	Uniform (-10, 1)
	F_{MSY}	Uniform (-10, 1)
	F_{ty}/F_{MSY}	Uniform (-8, 5)
	OFL_{ty}	Uniform (0, 25)
CV_g	Gamma (1, 0.01)	
v_r	Uniform (0, 10)	
v_{tp}	Uniform (0, 10)	
ω	Uniform (0, 100)	

Table S3. Model selection for the 7 estimates.

B_{ty}				F_{ty}			
Model	DIC	WAIC	LOO	Model	DIC	WAIC	LOO
M3-a	0	0	0	M3-a	0	0	0
M3-b	-8	22	3	M3-b	-8	17	10
M2	169	185	174	M2	35	64	57
M1	669	953	932	M1	447	718	732

B_{MSY}				F_{MSY}			
Model	DIC	WAIC	LOO	Model	DIC	WAIC	LOO
M3-a	0	0	0	M3-a	0	0	0
M3-b	-12	8	1	M3-b	-86	18	11
M2	-7	16	8	M2	70	19	12
M1	472	733	725	M1	111	566	553

B_{ty}/B_{MSY}				F_{ty}/F_{MSY}			
Model	DIC	WAIC	LOO	Model	DIC	WAIC	LOO
M3-b	0	0	0	M3-b	0	0	0
M2	8	1	5	M2	1	2	1
M3-a	7	1	8	M3-a	11	4	3
M1	198	270	278	M1	139	306	323

OFL_{ty}			
Model	DIC	WAIC	LOO
M3-b	0	0	0
M3-a	13	6	13
M2	32	17	18
M1	283	475	497

Table S4. DIC, WAIC, LOO and global mean CV for each model estimate (results only for the selected model) under two scenarios. The first scenario is the current setting that assumes that the truth is essentially the mean estimate, and assessment results are random and independent samples from an underlying distribution. The second scenario assumes that the last assessment is the best and the mean estimate is from the most recent assessment. Median values and 95% credible intervals (in the brackets) are listed.

Estimate	Selected model	Current setting (unknown)				= most recent estimate			
		DIC	WAIC	LOO	Global mean CV (%)	DIC	WAIC	LOO	Global mean CV
B_{ty}	M3-a	0	0	0	39 (29, 52)	1392	1504	1405	41 (31, 54)
F_{ty}	M3-a	0	0	0	46 (36, 59)	1381	1469	1367	48 (39, 61)
B_{MSY}	M3-a	0	0	0	31 (21, 49)	1353	1440	1403	33 (22, 47)
F_{MSY}	M3-a	0	0	0	23 (14, 38)	1078	1225	1190	22 (12, 41)
B_{ty} / B_{MSY}	M3-b	0	0	0	25 (18, 35)	1100	1174	1120	28 (20, 39)
F_{ty} / F_{MSY}	M3-b	0	0	0	43 (29, 64)	1221	1226	1178	46 (31, 64)
OFL_{ty}	M3-b	0	0	0	45 (31, 69)	1188	1251	1191	49 (34, 71)

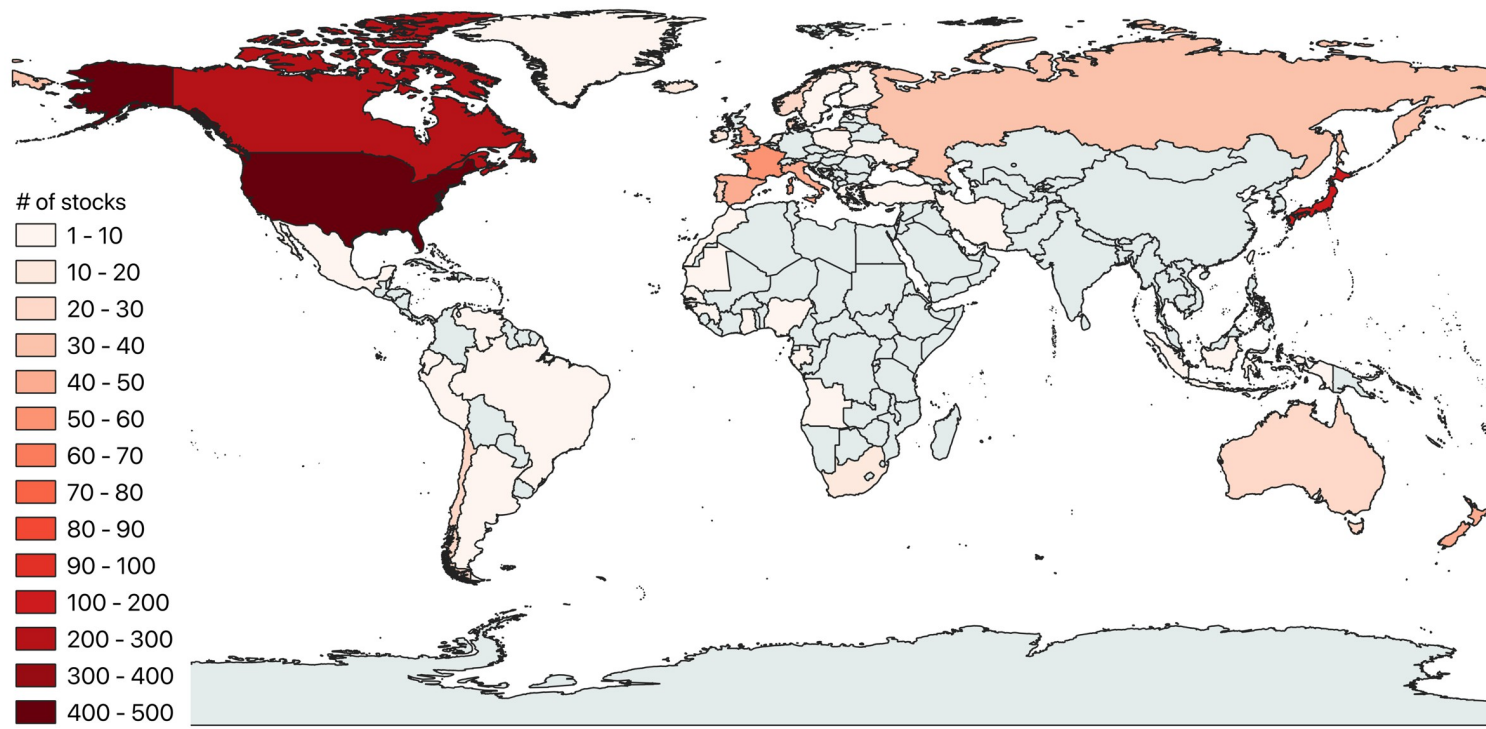


Figure S1. Distribution of stocks included in the RAM Legacy database (1,330 stocks in total). Each stock is an area-country-species triple. Map is built using QGIS3.10. There are 18 tuna stocks included in the database, including Southern bluefin tuna in the Indian Ocean, Bigeye tuna in the Eastern Pacific, Yellowfin tuna in the Eastern Pacific, Albacore tuna in the Mediterranean Sea, Albacore tuna in the Northern Atlantic, Albacore tuna in the South Atlantic, Atlantic bluefin tuna in the Eastern Atlantic, Atlantic bluefin tuna in the Western Atlantic, Bigeye tuna in the Atlantic Ocean, Yellowfin tuna in the Atlantic Ocean, Albacore tuna in the Indian Ocean, Bigeye tuna in the Indian Ocean, Yellowfin tuna in the Indian Ocean, Albacore tuna in the North Pacific Ocean, Pacific bluefin tuna in the Pacific Ocean, Albacore tuna in the South Pacific Ocean, Bigeye tuna in the Central Western Pacific Ocean, and Yellowfin tuna in the Central Western Pacific Ocean.

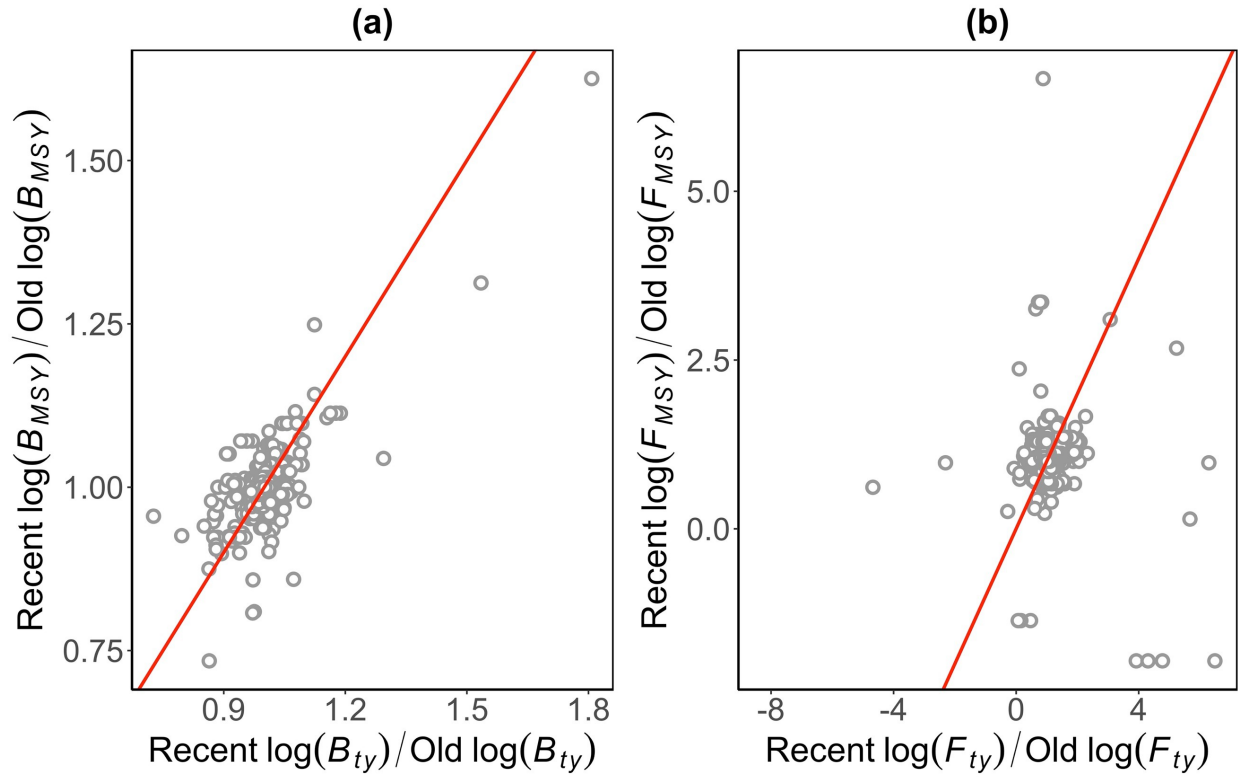


Figure S2. (a) A comparison of changes in B_{ty} and B_{MSY} , (b) a comparison of changes in F_{ty} and F_{MSY} . Plot is made using R package ggplot2 (version 3.3.2, <https://ggplot2.tidyverse.org>) in statistical program R (version 3.6.3, <http://www.R-project.org/>).

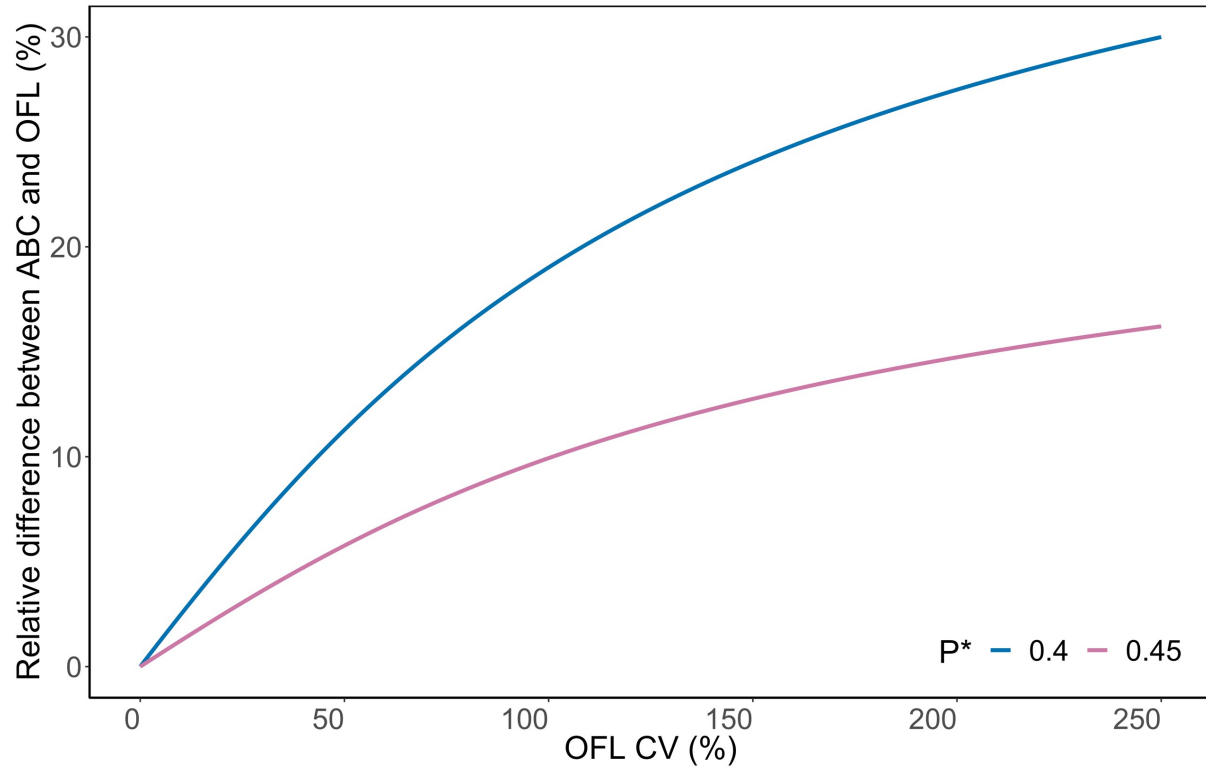


Figure S3. Relative difference between ABC and OFL (i.e., $\frac{\text{OFL} - \text{ABC}}{\text{OFL}} \times 100\%$) under different OFL CVs. The P^* is the target probability of overfishing, which is selected to set the ABC by fisheries managers. For example, with a $P^* = 0.4$, the 40th percentile of the OFL distribution, corresponding with a 40% chance of overfishing, is selected as the ABC.