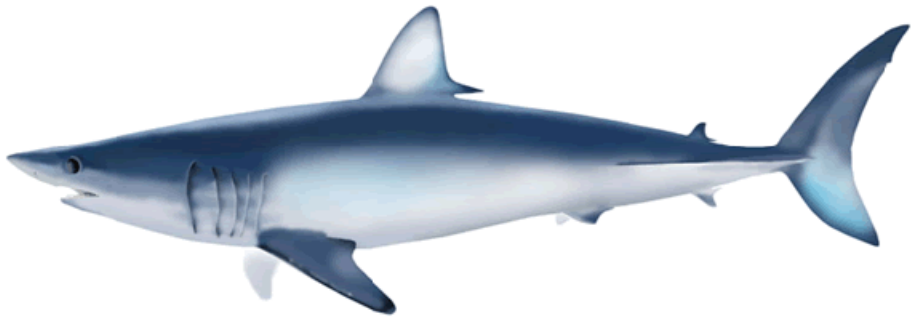
Progress on the updated Stock Synthesis stock assessment of Blue Shark in the North Pacific Ocean[1]

Joel Rice & Shelton Harley

Oceanic Fisheries Programme
Secretariat of the Pacific Community (SPC-OFP)
Noumea, New Caledonia
JoelR@spc.int



[1]Working document submitted to the ISC Shark Working Group Workshop, 13 - 18 January 2014, NOAA Southwest Fisheries Science Center, La Jolla, California, U.S.A.

SCIENTIFIC COMMITTEE
TENTH REGULAR SESSION

XXXX August 2014

Majuro -Marshall Islands

Progress on the updated Stock Synthesis stock assessment of Blue Shark in the North Pacific Ocean

WCPFC-SC10-2014/ SA-IP-XX

Joel Rice[1] Shelton Harley

[1] Oceanic Fisheries Programme, Secretariat of the Pacific Community (SPC-OFP), Noumea, New Caledonia.

Progress on the updated Stock Synthesis stock assessment of Blue Shark in the North Pacific Ocean

Oceanic Fisheries Programme, SPC *6th January 2014*

The purpose of this paper is to provide an update on progress since SC9 towards an updated assessment for blue shark in the North Pacific Ocean using stock synthesis. This paper does not include detailed data or analysis descriptions – these will be provided in the working paper(s) for the full assessment, for now the majority of the information set out in the SC9 and ISC documents still stands. An updated grid (Table 1) was run comprising 1200 runs in total, of which 854 resulted in an extant population at the end of the time series (1976-2011). In this paper we outline the major changes to the input data, assessment methods and describe the results based on each change.

A summary describes the change to the assessment and the impact on stock status from the previous paper (Table 2). The main alternative structural assumptions are the CPUE series and stock recruitment function (other axes represent alternative parameterizations, not structure), results (by Kobe plot status) are tabled across these main axes (Table 3). Kobe plots and tables of management quantities for each option are also presented (Appendix 1-8). Note that we have preferred to describe stock status with a large number of model runs (that include different assumptions and data sets) to capture uncertainty. As before this stock is assessed against traditional MSY based reference points, although reference points for sharks in the NPO have not been established.

Stepwise changes to the assessment from the previous paper were undertaken, initially changing the catch to reflect the updated catch, and then adding the updated CPUE (Figure 1). Figure 2 shows the Kobe plot for all the results while Figures 3 and 4 show biomass and spawning stock biomass depletion (respectively) for the eight combinations of CPUE series and SRR. Looking at the key sources of uncertainty we note that

- The conclusions on stock status from the stock assessment depended heavily 2 factors, the catch per unit effort series used and the stock recruitment curve. Some indices suggested major sustainability concerns and other suggested little concerns.
- The low fecundity stock recruitment relationship (LFSR) is generally more optimistic than the Beverton Holt stock recruitment relationship (BHSR).
- Across all model configurations no model runs with the BHSR resulted in a stock that was not overfished / no overfishing (Green quadrant).
- To be able to provide management advice based on either of the of the stock recruitment functions, and absent information pertaining to either steepness or beta and S_FRAC, absent this we rely on likelihood based approaches.
- The response to changes is the LFSR was quite complex:
    - For low Sfrac, MSY and FMSY (and overall stock condition) increased dramatically with increases of beta from 1 to 3, but the fit to the Japan late series was extremely poor (e.g. it did not predict the strong increase).
    - Under high Sfrac the model results were relatively consistent across the range of values of beta.

Table 1. Grid of runs from the updated assessment.

GROUP	Variable	SC9 Reference	SC9 Grid Alternatives	Change?	New Grid
CPUE					
	CPUE Series	JPN Early and Late	1)Japanese early and HW deep set & 2)Japanese early and Japan RTV	YES	1)JPN early & JPN Late 2)JPN early and Japan RTV 3)JPN early and new SPC 4)JPN early and SPC no HW
Natural Mortality					
	Natural Mortality	Chen and Watanabe (Low)	Peterson and Wroblewski (Hi)	NO	Peterson and Wroblewski (Hi) , Chen and Watanabe (Low)
Length Composition					
	Sample size for length frequency data	Scalar of 0.2	Scalar of 0.5 (upweight)	NO	Scalar of 0.2,& 0.5
Stock Recruitment					
	Stock Recruitment Function	**Low Fecundity** (Sfrac 0.35, Beta=2)	SFRAC=c(0.05, 0.13, 0.2); Beta= c(1,2,3)	YES	SFRAC=c(0.10, 0.20 , 0.30, 0.40 , 0.50); BETA= c(1,2,3,4)
		Beverton Holt		YES	Steepness=c(0.4, 0.5, 0.6, 0.7, 0.8)
	Sigma R (SD on the recruitment deviations)			YES	SigmaR =c(0.1, 0.3,0.5)
Catches/Fisheries		1 catch time series with 18 fisheries	None	No	1 catch time series with 18 fisheries
Region Structure		1 region		No	1 region
Time Frame		1976-2011		No	1976-2011
Selectivity					
	Length Based	Mirrored for those fisheries without length comps.		No	Mirrored for those fisheries without length comps.

Table 2. Summary of the key changes to the stock assessment presented to SC8 and the impacts of these on predicted stock status.

Change to the assessment	**Impact on stock status**
Update of the Japanese longline catch.	The **revised** Japanese longline catch had the effect of slightly lowering the final SSB / SSBmsy from the previous reference case.
Use of the updated JPN late CPUE series.	This **updated** series resulted in a decrease of the SSB/SSBmsy of approximately 10%.
Combined SPC/HWOB cpue series	These **new** series result in estimates of stock status predominantly in the red quadrant, but with a significant amount of orange (and a little green).
Additional Sigma R values	Additional runs at higher and lower Sigma R resulted in similar end year depletion ratios.
SPC only CPUE series.	The **new** CPUE resulted in outcomes largely in the red quadrant with the BHSR and the LFSR
Use of the Beverton – Holt stock recruitment function.	Across the major axes of uncertainty the inclusion of the BH SRR resulted in more stable pessimistic results.

Table 3. Distribution of stock status outcomes (percentage of model runs in each quadrant of the Kobe plot) for models that included different CPUE and catch time series (see Table 2 for further details of the data sets).

	Percent of Outcome in each Kobe Plot Quadrant			
CPUE and Stock Recruitment Function	RED	ORANGE	GREEN	YELLOW
JPN Early and JPN Late : BHSR	20	0	0	80
JPN Early and JPN Late : LFSR	45.6	2.07	8.81	43.52
JPN Early and RTV Late : BHSR	100	0	0	0
JPN Early and RTV Late : LFSR	68.38	6.84	24.79	0
JPN Early and SPC Tropic : BHSR	100	0	0	0
JPN Early and SPC Tropic : LFSR	81.58	3.68	14.74	0
JPN Early and SPC Combined : BHSR	92.86	0	0	7.14
JPN Early and SPC Combined : LFSR	90.72	0	7.73	1.55

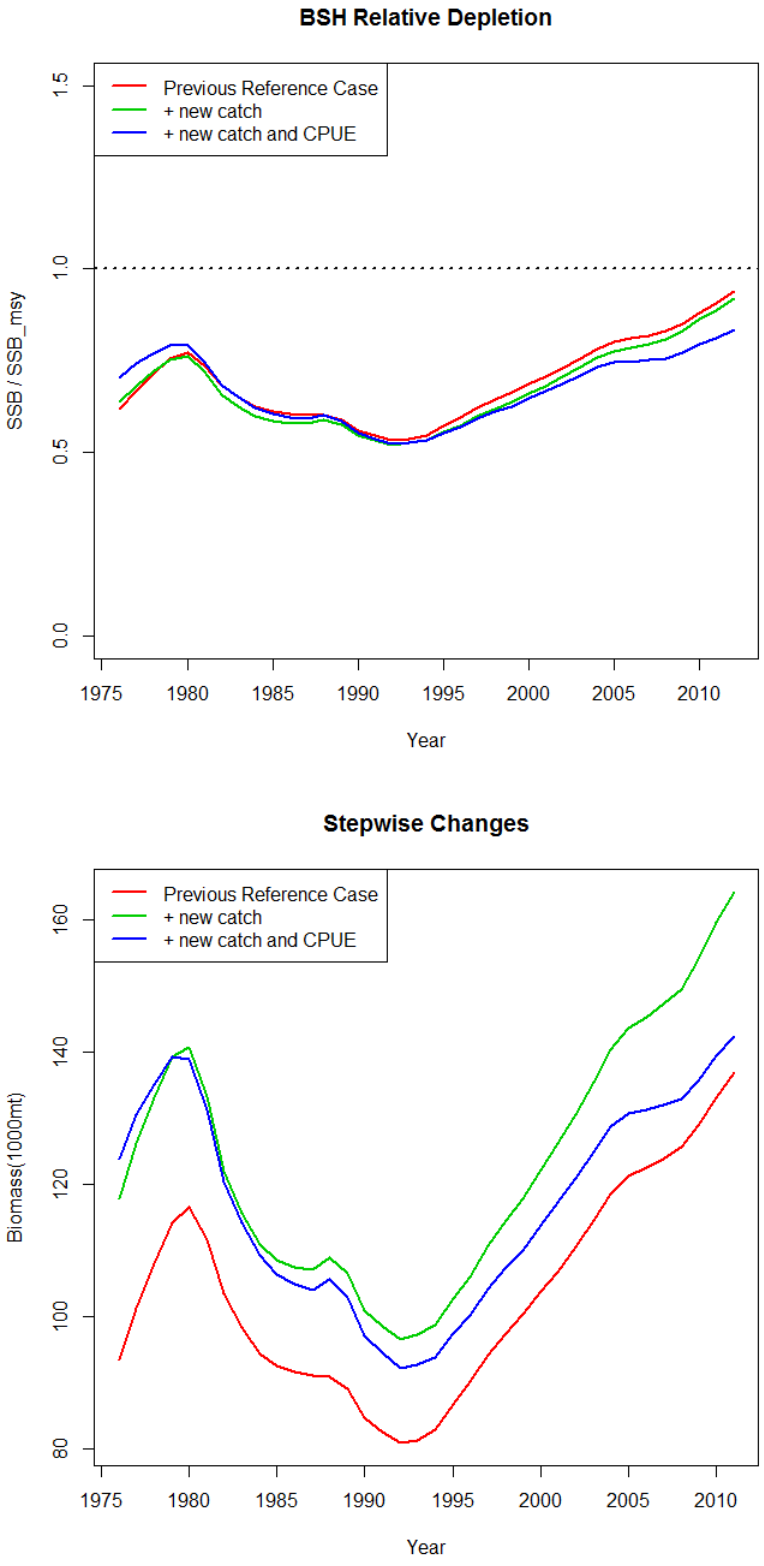


Figure 1 Depletion of SSB (relative to SSB_{msy}) for the previous reference case (red), the Reference case and new catch (green) and the reference case with the updated catch and CPUE , top panel. The bottom panel shows the biomass for the same runs.

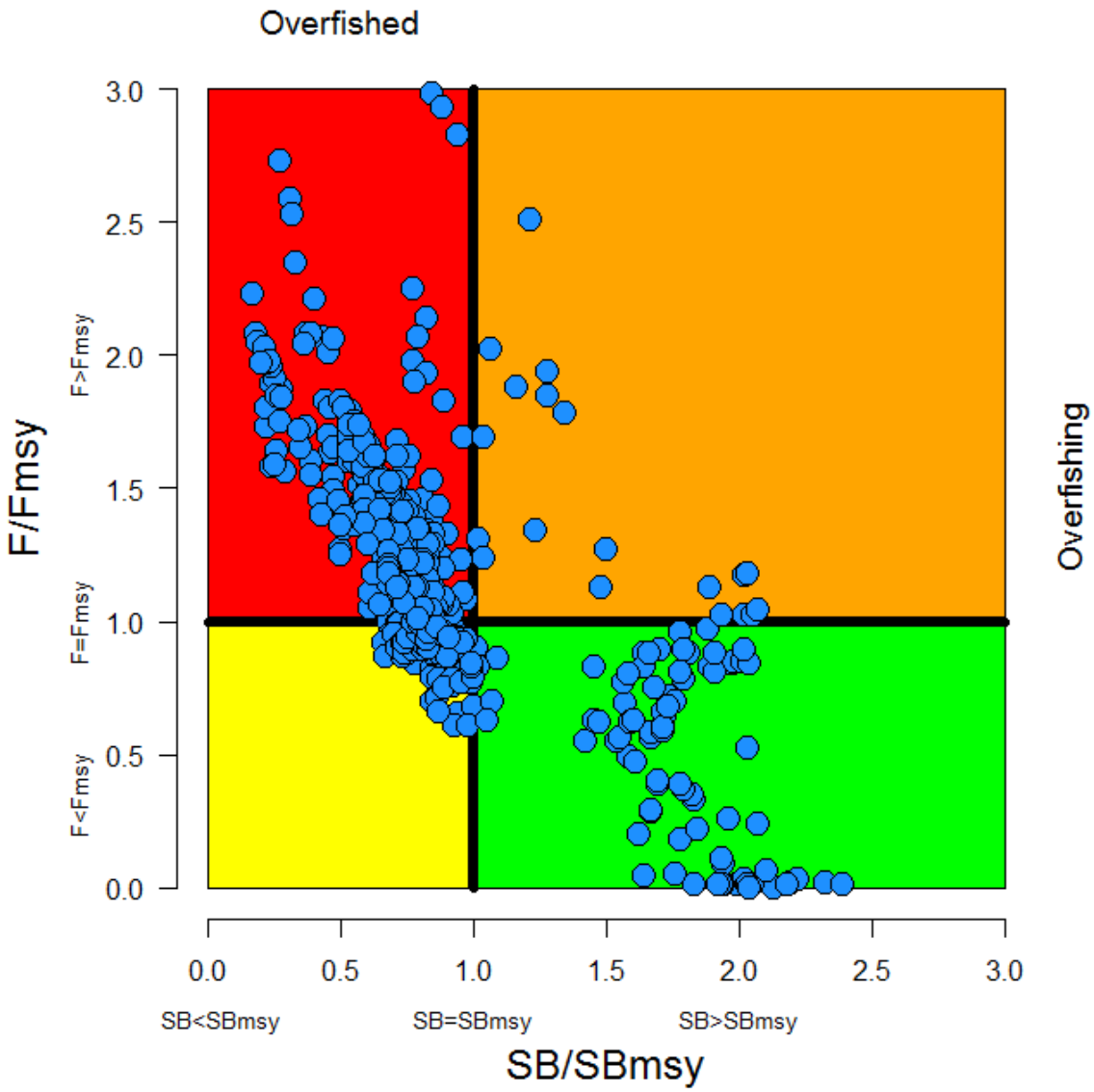


Figure 2 Kobe plots indicating annual stock status, relative to SB_{MSY} (x-axis) and F_{MSY} (y-axis). These present the reference points and based on the current (average of 2006-2010) estimates for all 854 successful models with an F/Fmsy ratio less than 3.

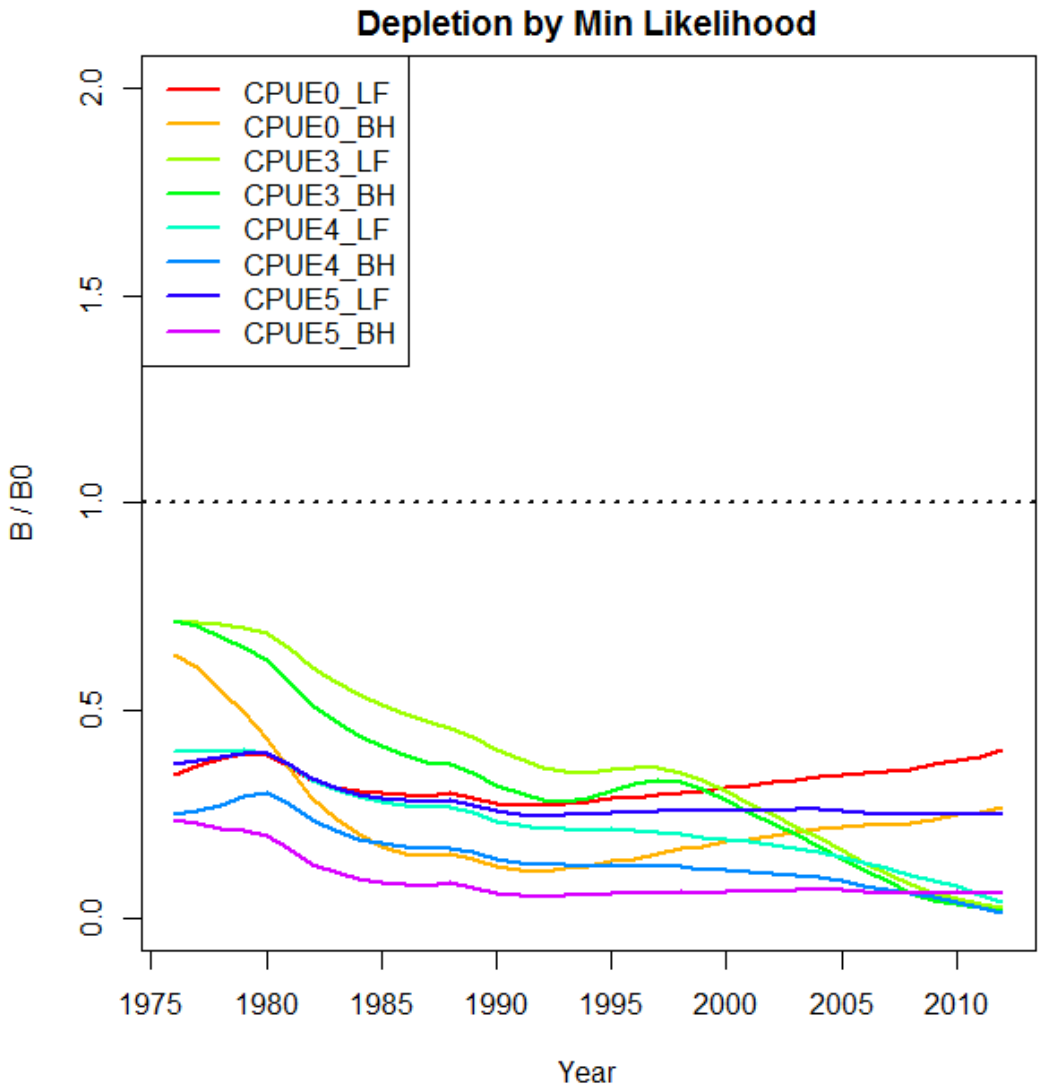


Figure 3 Biomass depletion by minimum likelihood across the axes of CPUE and stock recruitment function. LF and BH refer to the low fecundity and Beverton Holt stock recruitment relationships. CPUE 0 is JPN Early and JPN Late ; CPUE 3 is JPN Early and JPN RTV, CPUE 4 is JPN Early and SPC no HW, CPUE 5 is JPN Early and SPC Combined.

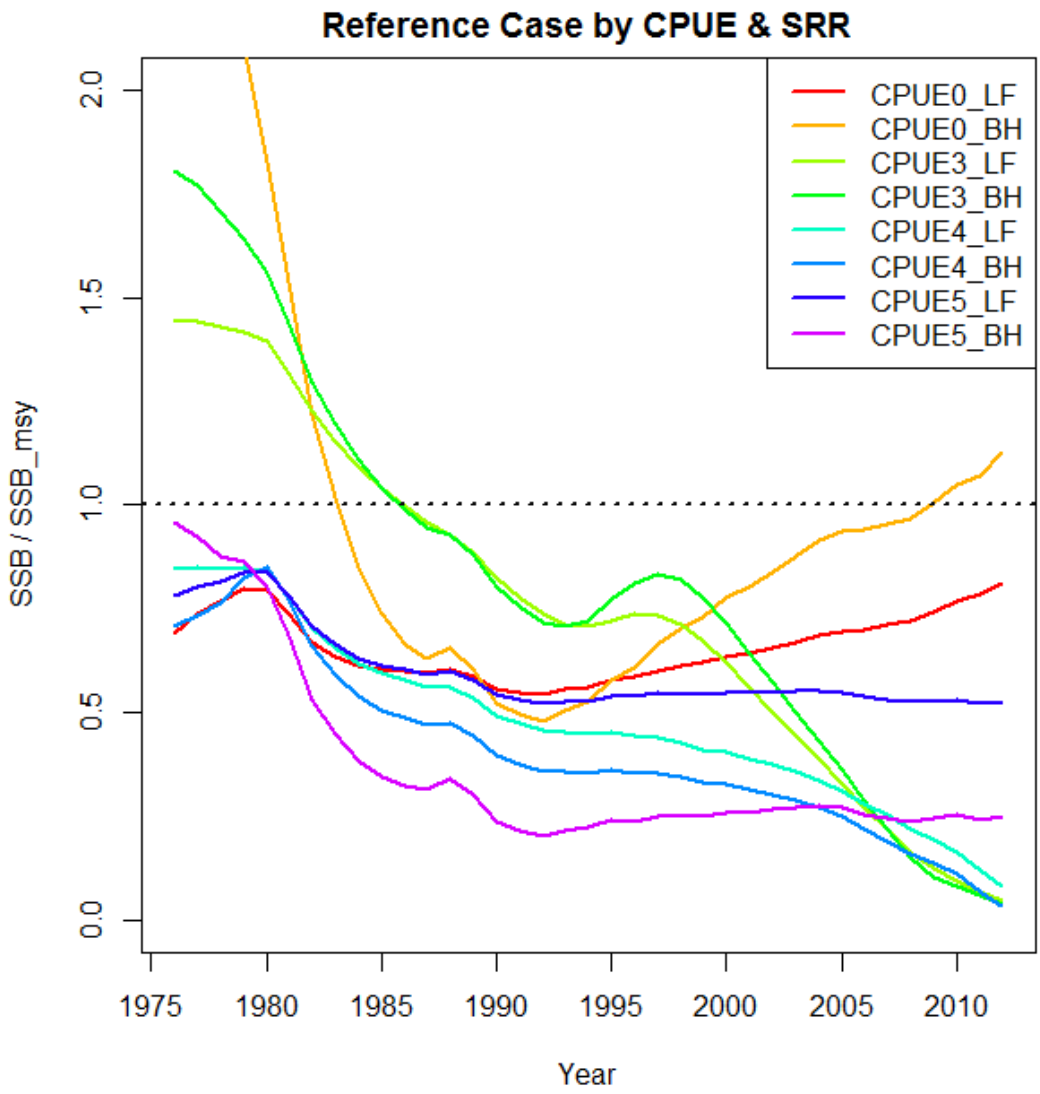
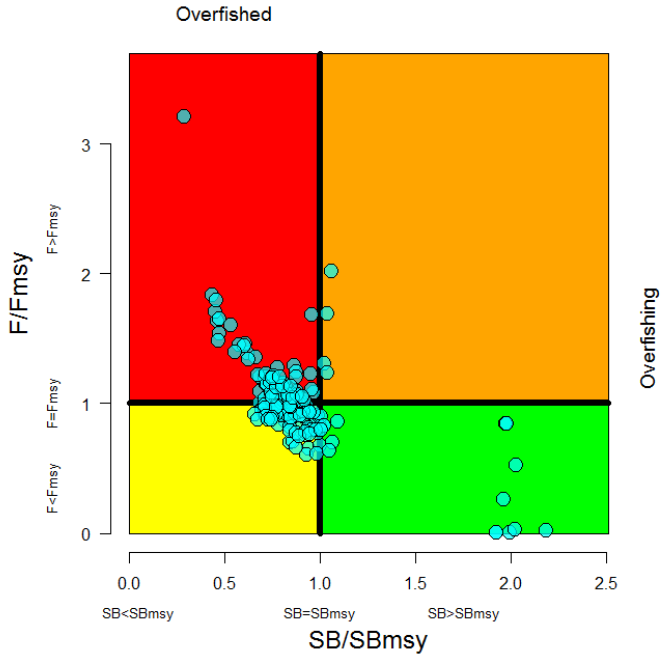


Figure 4. Spawning stock biomass depletion by minimum likelihood across the axes of CPUE and stock recruitment function. . LF and BH refer to the low fecundity and Beverton Holt stock recruitment relationships. CPUE 0 is JPN Early and JPN Late ; CPUE 3 is JPN Early and JPN RTV, CPUE 4 is JPN Early and SPC no HW, CPUE 5 is JPN Early and SPC Combined.

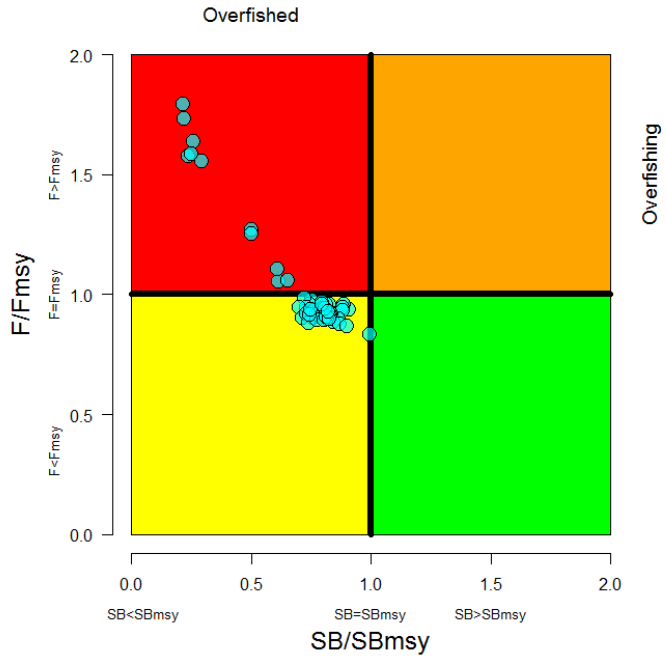
Appendix 1: JPN EARLY AND JPN LATE WITH LFSR

	Reference	Grid_Median	Grid_5%	Grid_95%
C_latest	33744	33744	33744	33744
Y_MSY	55040	60376	45103	82934
B_zero	1417460	3935810	2332808	9337114
B_msy	333221	1882726	1145733	4773442
B_cur	331469	1587104	777329	4411783
SB_zero	165071	455358	271669	1082904
SB_msy	38805	217057	133157	552622
SB_cur	38601	184827	90198	510819
B_cur/B_zero	0.23	0.42	0.27	0.56
B_cur/B_msy	0.99	0.83	0.57	1.08
SB_cur/SB_zero	0.23	0.42	0.27	0.56
SB_cur/SB_msy	0.99	0.83	0.57	1.08
B_msy/ B_zero	0.24	0.50	0.45	0.53
SB_msy/SB_zero	0.24	0.50	0.45	0.53
F_cur	0.44	0.17	0.07	0.31
F_msy	0.53	0.19	0.09	0.26
F_cur/F_msy	0.83	0.99	0.64	1.56



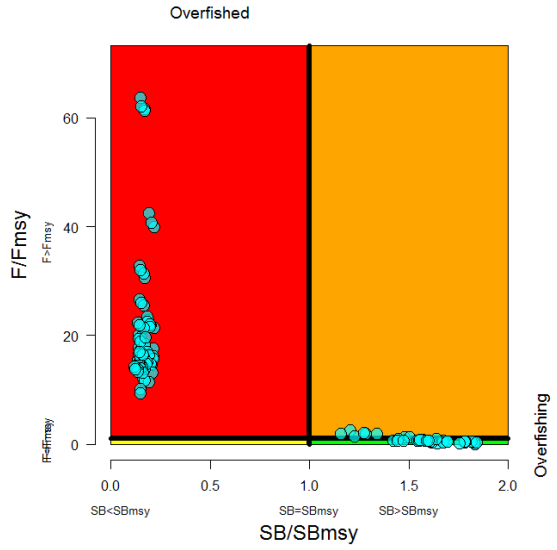
Appendix 2: JPN EARLY AND JPN LATE WITH BHSR

	Reference	Grid_Median	Grid_5%	Grid_95%
C_latest	33744	33744	33744	33744
Y_MSY	60772	61409	55331	80951
B_zero	2313380	2806530	1679809	5308384
B_msy	1147648	968653	419802	2133252
B_cur	845543	774395	156977	1724827
SB_zero	269406	326836	195623	611997
SB_msy	133650	112805	48888	245940
SB_cur	98468	89787	18138	198853
B_cur/B_zero	0.37	0.25	0.06	0.35
B_cur/B_msy	0.74	0.77	0.25	0.89
SB_cur/SB_zero	0.37	0.25	0.06	0.35
SB_cur/SB_msy	0.74	0.77	0.25	0.89
B_msy/ B_zero	0.50	0.32	0.24	0.40
SB_msy/SB_zero	0.50	0.32	0.24	0.40
F_cur	0.24	0.32	0.20	0.71
F_msy	0.21	0.35	0.21	0.49
F_cur/F_msy	1.16	0.93	0.88	1.60



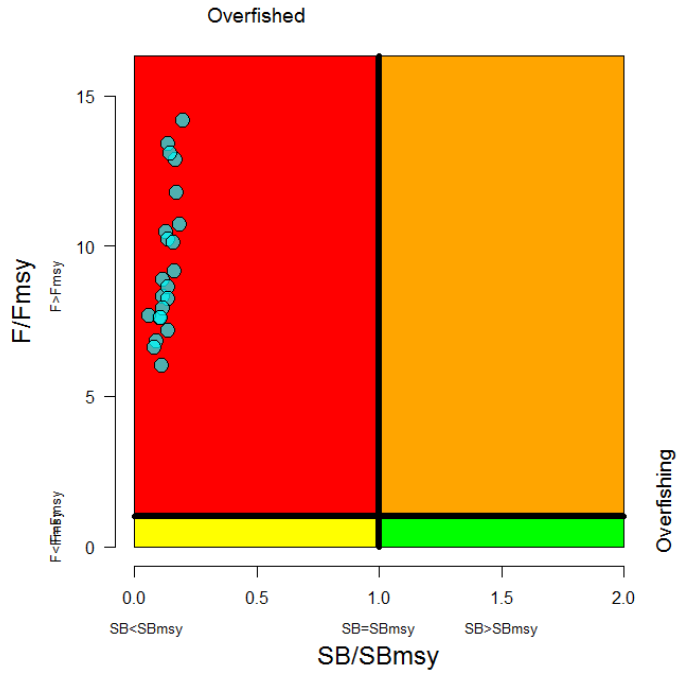
Appendix 3: JPN EARLY AND JPN RTV WITH LFSR

	Reference	Grid_Median	Grid_5%	Grid_95%
C_latest	33744	33744	33744	33744
Y_MSY	41826	44794	16836	130731
B_zero	2341750	3258450	2198474	8231064
B_msy	930715	1637710	1049132	4062145
B_cur	128561	291114	156525	7067898
SB_zero	272710	377172	256024	956594
SB_msy	108387	188809	120964	472017
SB_cur	14972	33562	18046	816550
B_cur/B_zero	0.05	0.09	0.07	0.88
B_cur/B_msy	0.14	0.18	0.14	1.78
SB_cur/SB_zero	0.05	0.09	0.07	0.88
SB_cur/SB_msy	0.14	0.18	0.14	1.78
B_msy/ B_zero	0.40	0.50	0.46	0.53
SB_msy/SB_zero	0.40	0.50	0.46	0.53
F_cur	3.46	2.77	0.05	3.43
F_msy	0.26	0.20	0.07	0.29
F_cur/F_msy	13.41	14.39	0.27	40.00



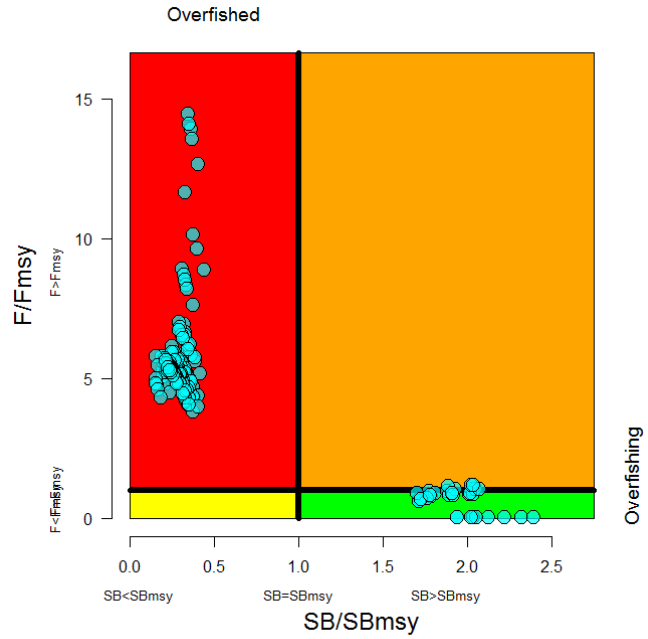
Appendix 4: JPN EARLY AND JPN RTV WITH BHSR

	Reference	Grid_Median	Grid_5%	Grid_95%
C_latest	33744	33744	33744	33744
Y_MSY	11819	54053	40237	62208
B_zero	3675190	2130295	1445392	2848188
B_msy	1812916	649202	335900	1022840
B_cur	270088	89201	27137	187314
SB_zero	427996	245599	168324	328364
SB_msy	211124	74846	39117	117922
SB_cur	31453	10284	3160	21595
B_cur/B_zero	0.07	0.04	0.02	0.07
B_cur/B_msy	0.15	0.14	0.08	0.18
SB_cur/SB_zero	0.07	0.04	0.02	0.07
SB_cur/SB_msy	0.15	0.14	0.08	0.18
B_msy/ B_zero	0.49	0.31	0.23	0.40
SB_msy/SB_zero	0.49	0.31	0.23	0.40
F_cur	2.78	3.87	3.24	4.65
F_msy	0.04	0.45	0.25	0.64
F_cur/F_msy	63.67	8.77	6.62	13.40



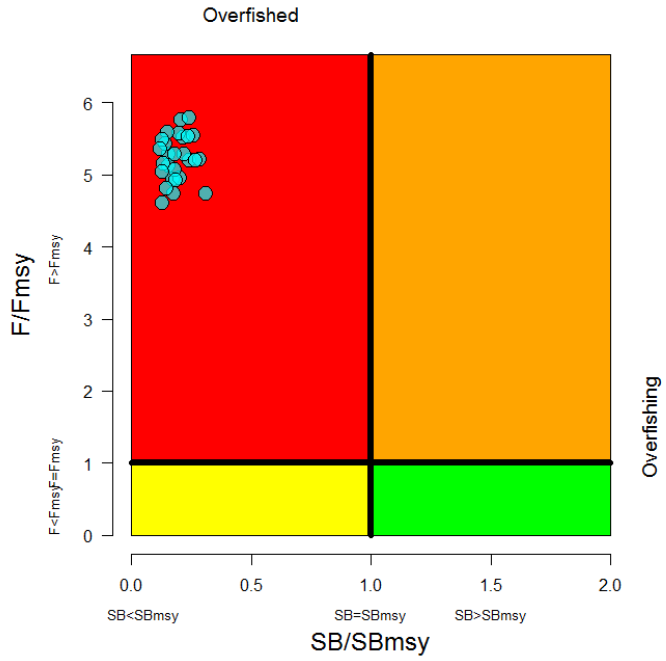
Appendix 5: JPN EARLY AND SPC ONLY WITH LFSR

	Reference	Grid_Median	Grid_5%	Grid_95%
C_latest	33744	33744	33744	33744
Y_MSY	60160	42886	20486	81939
B_zero	2529630	3020315	2081959	4887633
B_msy	897520	1485913	1020626	2394261
B_cur	134335	506644	226862	2965961
SB_zero	294589	349827	241194	563489
SB_msy	104521	173043	118410	276031
SB_cur	15644	58706	26276	341941
B_cur/B_zero	0.05	0.16	0.09	1.02
B_cur/B_msy	0.15	0.32	0.19	2.03
SB_cur/SB_zero	0.05	0.16	0.09	1.02
SB_cur/SB_msy	0.15	0.32	0.19	2.03
B_msy/ B_zero	0.35	0.50	0.45	0.53
SB_msy/SB_zero	0.35	0.50	0.45	0.53
F_cur	1.58	0.77	0.12	1.30
F_msy	0.28	0.18	0.08	0.26
F_cur/F_msy	5.58	5.15	0.59	8.79



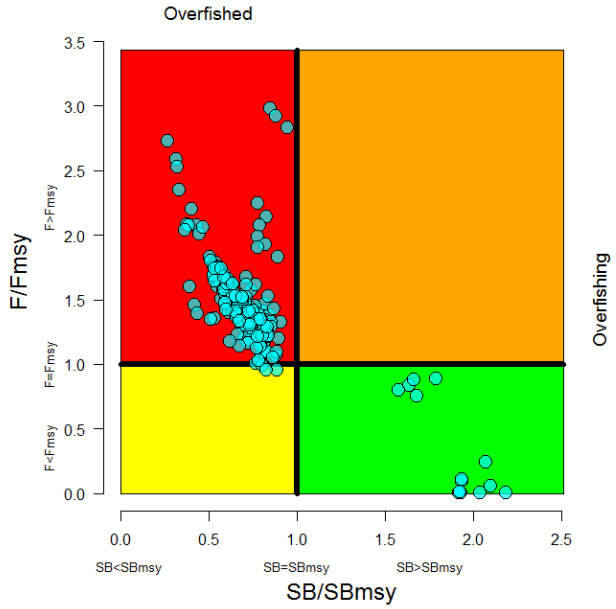
Appendix 6: JPN EARLY AND SPC ONLY WITH BHSR

	Reference	Grid_Median	Grid_5%	Grid_95%
C_latest	33744	33744	33744	33744
Y_MSY	60160	42886	20486	81939
B_zero	2529630	3020315	2081959	4887633
B_msy	897520	1485913	1020626	2394261
B_cur	134335	506644	226862	2965961
SB_zero	294589	349827	241194	563489
SB_msy	104521	173043	118410	276031
SB_cur	15644	58706	26276	341941
B_cur/B_zero	0.05	0.16	0.09	1.02
B_cur/B_msy	0.15	0.32	0.19	2.03
SB_cur/SB_zero	0.05	0.16	0.09	1.02
SB_cur/SB_msy	0.15	0.32	0.19	2.03
B_msy/ B_zero	0.35	0.50	0.45	0.53
SB_msy/SB_zero	0.35	0.50	0.45	0.53
F_cur	1.58	0.77	0.12	1.30
F_msy	0.28	0.18	0.08	0.26
F_cur/F_msy	5.58	5.15	0.59	8.79



Appendix 7: JPN EARLY AND COMBINED OBSERVER DATA WITH LFSR

	Reference	Grid_Median	Grid_5%	Grid_95%
C_latest	33744	33744	33744	33744
Y_MSY	70343	53316	36806	161223
B_zero	1631050	3472550	2255434	8852073
B_msy	398508	1688951	1082371	4248485
B_cur	97272	1246462	586945	5272967
SB_zero	189945	402372	262657	1020543
SB_msy	46409	194923	126048	489802
SB_cur	11328	144854	68117	607914
B_cur/B_zero	0.06	0.35	0.20	0.92
B_cur/B_msy	0.24	0.71	0.42	1.83
SB_cur/SB_zero	0.06	0.35	0.20	0.92
SB_cur/SB_msy	0.24	0.71	0.42	1.83
B_msy/ B_zero	0.24	0.50	0.44	0.53
SB_msy/SB_zero	0.24	0.50	0.44	0.53
F_cur	0.90	0.24	0.09	0.45
F_msy	0.46	0.19	0.09	0.26
F_cur/F_msy	1.96	1.41	0.58	2.10



Appendix 8: JPN EARLY AND COMBINED OBSERVER DATA WITH BHSR

	Reference	Grid_Median	Grid_5%	Grid_95%
C_latest	33744	33744	33744	33744
Y_MSY	56304	57153	49580	81213
B_zero	2413540	2726255	1635603	4527085
B_msy	1141011	862493	432406	1818931
B_cur	603196	556638	98437	1311628
SB_zero	281070	314307	190475	521922
SB_msy	132877	99939	50356	209702
SB_cur	70246	64823	11464	151216
B_cur/B_zero	0.25	0.22	0.05	0.32
B_cur/B_msy	0.53	0.66	0.20	0.88
SB_cur/SB_zero	0.25	0.22	0.05	0.32
SB_cur/SB_msy	0.53	0.66	0.20	0.88
B_msy/ B_zero	0.47	0.32	0.24	0.40
SB_msy/SB_zero	0.47	0.32	0.24	0.40
F_cur	0.36	0.40	0.26	0.90
F_msy	0.21	0.35	0.21	0.46
F_cur/F_msy	1.69	1.33	0.97	2.03