DEVELOPMENT OF A NEW WCPFC TROPICAL TUNA MEASURE WORKSHOP 4 (TTMW4)

Pohnpei, FSM

29 – 30 September 2023

RESULTS OF SPC ANALYSES REQUESTED BY TTMW3

and

PRELIMINARY EVALUATION OF CMM 2021-01

WCPFC-TTMW4-2023-04 REV2[1]

26 September 2023

SPC-OFP

Pacific Community (SPC), Noumea, New Caledonia

[1] REV1: Labelling error in Tables 8 and 9 corrected (Final longline multiplier group relabelled as 2019 levels).
REV2: Figure 7 optimistic long term recruitment plot corrected.

Summary

The 3rd workshop on the Development of a new Tropical Tuna Measure (TTMW3, June 2023) requested specific analyses from the Scientific Services Provider (SSP) to help inform Commission members on options for the new Measure (see Attachment 3 of WCPFC-TTMW3-2023-Chair's Report; Appendix 1 to this report). The results of these analyses are presented here. They have been grouped into different overall categories and re-ordered accordingly by the Scientific Services Provider. For each analysis, a short methodological summary is provided where necessary, particularly where interpretation of the request by the SSP was necessary to perform the analysis. This is then followed by the results and where appropriate, key points for CCMs to note when interpreting those results.

The TTMW3 requests are divided into three categories:

- 'trade-offs', reflecting requests that required a balance between purse seine and longline fishing;
- 'purse seine management', reflecting requests focussed on purse seine fishing levels; and
- 'longline management', reflecting requests focussed on longline fishing levels.

Requests have been allocated a sequential number for ease of reference.

SC19 additionally requested that the results of a re-evaluation of CMM 2021-01 based upon the accepted 2023 stock assessments of WCPO bigeye and yellowfin be provided to TTMW4 (WCPFC20-2023-SC19-01; paragraph 202). While the SSP did not have the capacity to complete the full revision of the CMM evaluation in time for TTMW4, we have prioritized the update to key components of Tables 1 and 2 of WCPFC19-2022-13_rev1, which are presented as part of the response to request #1. The full re-evaluation will be provided to WCPFC20.

Trade-offs

#	Request to SPC
1	Produce the usual depletion/risk matrices (nuclear grid) for BET and YFT based on LL and PS scalers using the 2023 assessment grids.
2	Trade off between FAD closure period (EEZ/HS), and LL catch. Cf EEZ vs HS FAD closure, FAD closure and LL catch (table 9 of WCPFC-TTMW2-2021-01_rev4/ Tables 11-13 in WCPFC18-2021-15)
3	Identify the biomass depletion levels associated with various candidate TRPs (i.e., 2012-2015 depletion, 2004 depletion, depletion associated with a risk level, 2001-2004 average levels), and the LL/PS scalars that achieve those biomass depletion levels
4	Examine the conditions necessary to achieve a BET TRP at 2012-15 depletion levels, where the FAD closure has been removed
5	Update Tables 9 and 10 of WCPFC18-2021-15 based upon the new assessment

1 Depletion/risk matrices for bigeye and yellowfin based on longline and purse seine scalars using the 2023 assessment grids.

Analyses conducted to evaluate the TT-CMM and to determine future management options were based on stochastic projections conducted across the grids of the most recent stock assessment models for bigeye and yellowfin tuna agreed by SC19 (WCPFC20-2023-SC19-01). Projections were run for a period of 30 years (2022 to 2051) with scalars applied to mean longline catch and purse seine effort for the period 2019-2021. For longline and purse seine fisheries, a range of catch and effort scalars (0.5 to 2.0 in increments of 0.05) were applied. For all other fisheries (pole and line fisheries and domestic fisheries of ID, PH, VN) fixed scalars were applied corresponding to the catch or effort change necessary to achieve baseline fishing levels as specified under the interim skipjack tuna management procedure (CMM 2022-01). These baseline levels are 2001-2004 effort levels for pole and line fisheries, and 2016-2018 average catches for domestic ID/PH/VN fisheries. These baselines were applied to be consistent with the skipjack management procedure assumptions.

Stochastic projections were run for each species, assessment model and scalar combination with future recruitment resampled from the 'long term' historical period (1962 - 2020 q2). An additional 'recent' recruitment scenario was run for bigeye tuna with future recruitment resampled from the last 10 years (2010 q3 – 2020 q2). Twenty stochastic projections were run for each of the 54 models in the uncertainty grids of the recent yellowfin and bigeye assessment and the scalar combination (961) totalling 1,037,880 projections for each species and recruitment range combination.

The resulting depletion at the end of the 30 year projection, and corresponding risk of falling below the LRP ($SB/SB_{F=0} < 0.2$) are presented in Figure 1 to Figure 6. The table of results corresponding to these plots are provided in the accompanying EXCEL spreadsheet. Outcomes for bigeye and yellowfin are presented relative to the objective in CMM 2021-01 of 'the spawning biomass depletion ratio ($SB/SB_{F=0}$) is to be maintained at or above the average $SB/SB_{F=0}$ for 2012-2015'[2].

While performing these analyses, two issues were identified:

1. Within the bigeye analyses, projections off one specific grid model consistently failed. Given the time available, the results from this specific model are not included herein.
2. For the yellowfin model, the assumption of constant catch for the domestic fisheries in 'Region 2' of the 2023 yellowfin assessment (i.e. ID/PH/VN region) led to the stock in that region failing under many future scenarios. This biases the overall outcome downwards (more depleted stock, greater risk). The assumption of constant catch is obviously unrealistic in the face of a declining stock and projections based on effort are preferable. We are examining the potential to assume 2016-18 effort levels for these fisheries.

We aim to try to address both these issues prior to WCPFC20.

[2] In calculating this level for each assessment model, we calculate the $SB_t/SB_{F=0,t-1tot-10}$ for each year, and take the average of these values.

PS scalar

LL scalar	0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95	1	1.05	1.1	1.15	1.2	1.25	1.3	1.35	1.4	1.45	1.5	1.55	1.6	1.65	1.7	1.75	1.8	1.85	1.9	1.95	2
0.5	0.619	0.609	0.599	0.59	0.581	0.572	0.564	0.557	0.549	0.542	0.534	0.528	0.521	0.515	0.509	0.503	0.498	0.493	0.488	0.483	0.478	0.473	0.469	0.465	0.46	0.457	0.453	0.449	0.446	0.443	0.439
0.55	0.611	0.601	0.592	0.582	0.573	0.565	0.557	0.549	0.541	0.534	0.527	0.52	0.514	0.507	0.502	0.496	0.49	0.485	0.48	0.475	0.47	0.465	0.461	0.457	0.453	0.449	0.445	0.441	0.438	0.435	0.431
0.6	0.604	0.593	0.584	0.575	0.566	0.557	0.549	0.541	0.534	0.526	0.519	0.512	0.506	0.5	0.494	0.488	0.483	0.477	0.472	0.467	0.462	0.458	0.453	0.449	0.445	0.441	0.437	0.434	0.43	0.427	0.423
0.65	0.596	0.586	0.576	0.567	0.558	0.55	0.542	0.534	0.526	0.519	0.512	0.505	0.499	0.492	0.486	0.48	0.475	0.469	0.464	0.459	0.455	0.45	0.446	0.442	0.437	0.433	0.429	0.426	0.422	0.419	0.415
0.7	0.589	0.578	0.569	0.56	0.551	0.542	0.534	0.526	0.518	0.511	0.504	0.498	0.491	0.485	0.478	0.472	0.467	0.461	0.456	0.451	0.447	0.442	0.438	0.434	0.429	0.425	0.422	0.418	0.414	0.411	0.408
0.75	0.581	0.571	0.561	0.552	0.543	0.535	0.526	0.518	0.511	0.503	0.496	0.489	0.483	0.477	0.47	0.465	0.459	0.453	0.448	0.443	0.439	0.434	0.43	0.426	0.422	0.418	0.414	0.41	0.407	0.404	0.401
0.8	0.574	0.564	0.553	0.544	0.536	0.527	0.519	0.511	0.503	0.495	0.488	0.482	0.475	0.469	0.463	0.457	0.451	0.446	0.441	0.436	0.431	0.427	0.422	0.418	0.415	0.41	0.407	0.403	0.4	0.396	0.393
0.85	0.566	0.556	0.546	0.537	0.528	0.52	0.511	0.504	0.495	0.488	0.481	0.474	0.467	0.461	0.455	0.449	0.444	0.439	0.434	0.428	0.424	0.419	0.415	0.411	0.407	0.403	0.399	0.396	0.392	0.389	0.386
0.9	0.559	0.549	0.539	0.53	0.521	0.512	0.504	0.496	0.488	0.48	0.473	0.467	0.46	0.453	0.448	0.442	0.436	0.431	0.426	0.421	0.417	0.412	0.408	0.404	0.4	0.396	0.392	0.389	0.385	0.382	0.378
0.95	0.551	0.541	0.532	0.522	0.513	0.505	0.496	0.488	0.48	0.472	0.465	0.459	0.452	0.446	0.44	0.434	0.429	0.423	0.418	0.414	0.409	0.405	0.401	0.396	0.392	0.388	0.385	0.381	0.377	0.374	0.371
1	0.544	0.534	0.524	0.515	0.506	0.497	0.488	0.48	0.472	0.465	0.458	0.451	0.445	0.439	0.433	0.427	0.421	0.416	0.411	0.406	0.402	0.397	0.393	0.389	0.385	0.38	0.377	0.373	0.37	0.367	0.363
1.05	0.537	0.527	0.517	0.507	0.498	0.489	0.481	0.473	0.465	0.457	0.45	0.444	0.437	0.431	0.425	0.419	0.414	0.409	0.404	0.399	0.394	0.39	0.386	0.381	0.377	0.373	0.37	0.366	0.363	0.359	0.356
1.1	0.53	0.519	0.51	0.5	0.49	0.482	0.473	0.465	0.457	0.45	0.443	0.436	0.429	0.423	0.418	0.412	0.407	0.401	0.396	0.391	0.387	0.382	0.378	0.374	0.37	0.366	0.362	0.359	0.355	0.352	0.348
1.15	0.522	0.512	0.502	0.492	0.483	0.474	0.466	0.458	0.45	0.442	0.435	0.428	0.422	0.416	0.41	0.405	0.399	0.394	0.389	0.384	0.379	0.375	0.37	0.367	0.362	0.359	0.355	0.351	0.348	0.344	0.341
1.2	0.515	0.505	0.494	0.484	0.475	0.467	0.458	0.45	0.442	0.434	0.427	0.421	0.415	0.409	0.403	0.397	0.392	0.387	0.381	0.376	0.371	0.368	0.363	0.359	0.355	0.351	0.347	0.343	0.34	0.337	0.334
1.25	0.507	0.497	0.486	0.477	0.468	0.459	0.451	0.443	0.434	0.427	0.42	0.414	0.407	0.402	0.395	0.39	0.385	0.379	0.374	0.369	0.365	0.36	0.356	0.352	0.348	0.344	0.34	0.336	0.333	0.33	0.327
1.3	0.5	0.489	0.479	0.469	0.46	0.451	0.443	0.435	0.427	0.42	0.413	0.406	0.4	0.394	0.388	0.383	0.377	0.372	0.367	0.362	0.358	0.353	0.349	0.344	0.34	0.336	0.333	0.329	0.326	0.323	0.32
1.35	0.493	0.482	0.472	0.462	0.453	0.444	0.436	0.427	0.42	0.412	0.406	0.399	0.393	0.387	0.381	0.376	0.37	0.365	0.36	0.355	0.35	0.346	0.341	0.337	0.333	0.329	0.326	0.322	0.319	0.315	0.312
1.4	0.485	0.474	0.464	0.454	0.446	0.437	0.428	0.42	0.413	0.405	0.398	0.392	0.385	0.38	0.374	0.368	0.363	0.358	0.352	0.347	0.343	0.338	0.334	0.33	0.326	0.322	0.318	0.315	0.311	0.308	0.305
1.45	0.478	0.467	0.456	0.447	0.438	0.429	0.421	0.413	0.405	0.398	0.391	0.384	0.378	0.373	0.367	0.361	0.356	0.35	0.345	0.34	0.336	0.331	0.327	0.322	0.318	0.315	0.311	0.307	0.304	0.301	0.298
1.5	0.47	0.459	0.449	0.44	0.431	0.422	0.413	0.405	0.398	0.391	0.384	0.377	0.371	0.365	0.36	0.354	0.348	0.343	0.338	0.333	0.328	0.323	0.319	0.315	0.311	0.307	0.304	0.3	0.296	0.293	0.29
1.55	0.463	0.451	0.442	0.432	0.423	0.414	0.406	0.398	0.39	0.383	0.377	0.37	0.364	0.358	0.352	0.346	0.341	0.335	0.33	0.325	0.321	0.316	0.312	0.308	0.304	0.3	0.296	0.293	0.289	0.286	0.283
1.6	0.454	0.444	0.434	0.424	0.416	0.407	0.399	0.391	0.383	0.376	0.37	0.363	0.357	0.351	0.345	0.339	0.334	0.328	0.323	0.318	0.314	0.309	0.305	0.301	0.297	0.293	0.289	0.286	0.283	0.279	0.276
1.65	0.447	0.437	0.427	0.417	0.409	0.4	0.392	0.384	0.376	0.369	0.362	0.356	0.35	0.344	0.338	0.332	0.326	0.321	0.316	0.311	0.306	0.302	0.298	0.293	0.289	0.285	0.282	0.279	0.276	0.272	0.269
1.7	0.44	0.429	0.419	0.41	0.401	0.393	0.385	0.376	0.369	0.362	0.355	0.349	0.342	0.336	0.33	0.325	0.319	0.314	0.308	0.303	0.299	0.294	0.29	0.286	0.282	0.278	0.275	0.272	0.268	0.264	0.261
1.75	0.432	0.422	0.412	0.403	0.394	0.386	0.377	0.369	0.362	0.355	0.348	0.341	0.335	0.329	0.323	0.317	0.312	0.306	0.301	0.296	0.292	0.287	0.283	0.279	0.275	0.272	0.268	0.264	0.261	0.257	0.254
1.8	0.425	0.415	0.405	0.396	0.387	0.378	0.37	0.362	0.355	0.348	0.341	0.334	0.328	0.322	0.316	0.31	0.305	0.299	0.294	0.289	0.285	0.28	0.276	0.272	0.268	0.265	0.261	0.257	0.253	0.25	0.247
1.85	0.418	0.408	0.398	0.388	0.379	0.371	0.362	0.355	0.348	0.34	0.334	0.327	0.321	0.314	0.308	0.303	0.297	0.292	0.287	0.282	0.277	0.273	0.269	0.265	0.261	0.257	0.253	0.25	0.247	0.244	0.241
1.9	0.41	0.4	0.39	0.381	0.372	0.363	0.356	0.348	0.34	0.333	0.327	0.32	0.313	0.307	0.301	0.295	0.29	0.285	0.28	0.275	0.271	0.267	0.262	0.257	0.254	0.25	0.246	0.243	0.24	0.238	0.234
1.95	0.403	0.393	0.383	0.373	0.364	0.356	0.349	0.341	0.333	0.326	0.319	0.313	0.306	0.3	0.294	0.288	0.283	0.277	0.272	0.268	0.264	0.259	0.255	0.251	0.247	0.243	0.24	0.237	0.234	0.231	0.228
2	0.396	0.385	0.375	0.366	0.358	0.349	0.341	0.334	0.326	0.319	0.312	0.305	0.299	0.293	0.286	0.281	0.275	0.27	0.266	0.261	0.256	0.252	0.248	0.244	0.24	0.237	0.233	0.23	0.227	0.224	0.222

>0.44
0.34 to 0.44
0.24 to 0.34
< 0.24

Figure 1. Bigeye equilibrium stock depletion levels ($SB/SB_{F=0}$) resulting under the different purse seine (across) and longline (down) scalars (relative to 2019-21 levels), under the assumption that 'recent' recruitment levels continue. Values indicate equilibrium depletion levels resulting under fishery conditions. Shading indicates depletions relative to average stock depletion levels over the period 2012-15 (34%$SB_{F=0}$), consistent with CMM 2021-01.

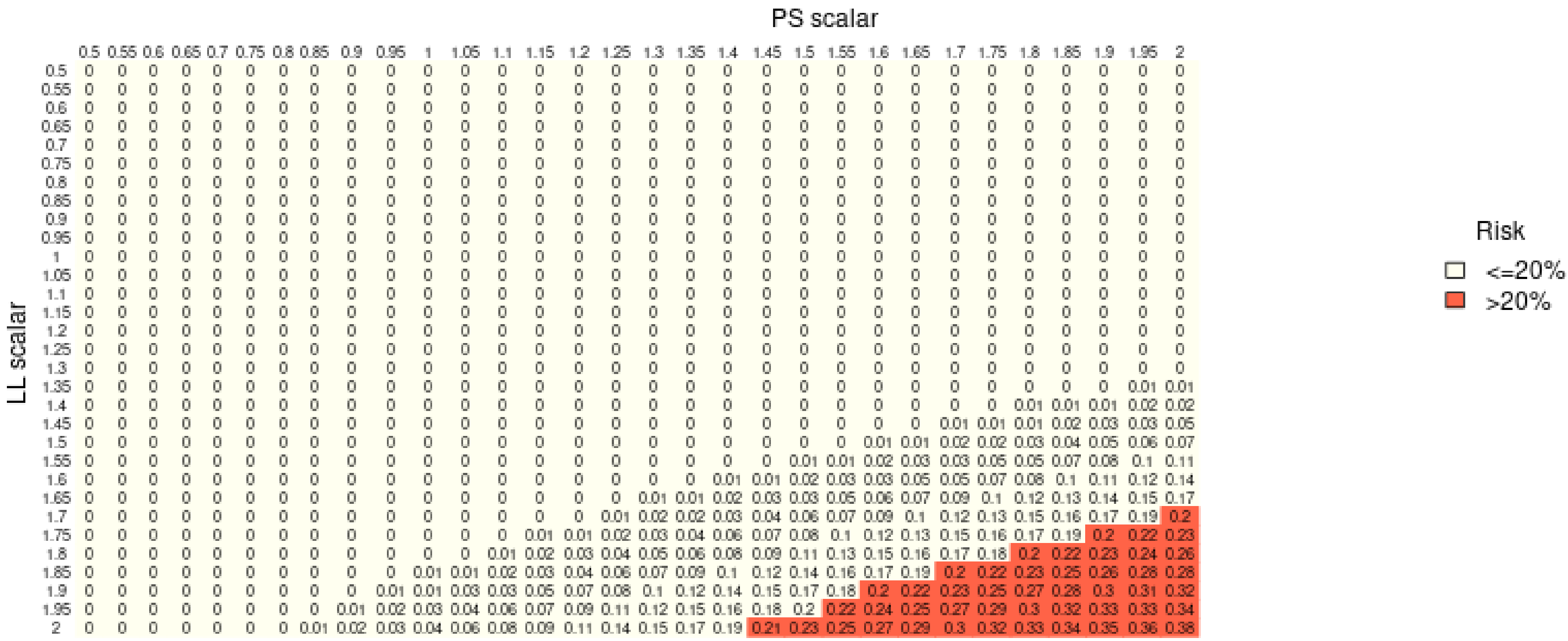


Figure 2. Risk that the bigeye stock depletion levels ($SB/SB_{F=0}$) resulting under the different purse seine (across) and longline (down) scalars (relative to 2019-21 levels), under the assumption that 'recent' recruitment levels continue, will fall below the limit reference point. Values indicate the risk level under those fishery conditions, shading indicates those risk levels less than or equal to, and greater than 20%.

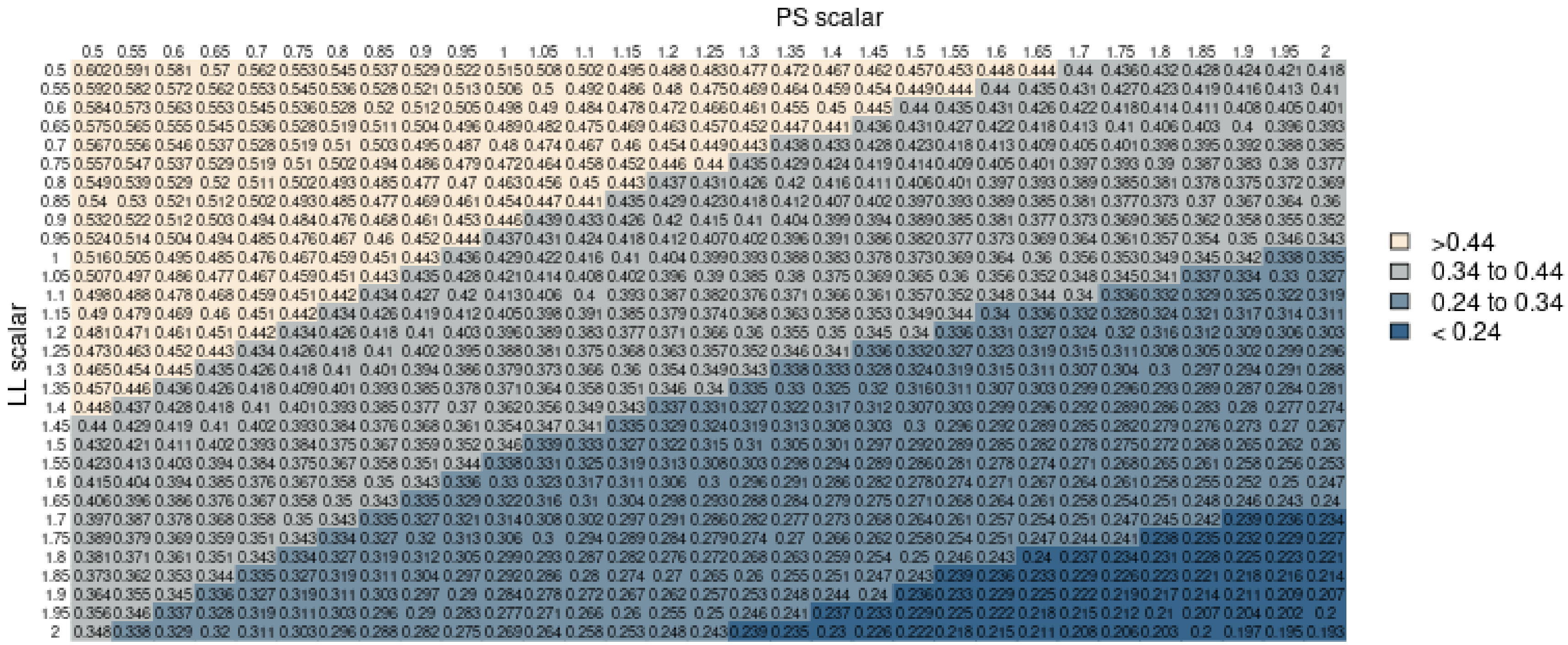


Figure 3. Bigeye equilibrium stock depletion levels ($SB/SB_{F=0}$) resulting under the different purse seine (across) and longline (down) scalars (relative to 2019-21 levels), under the assumption that 'long term' recruitment levels continue. Values indicate equilibrium depletion levels resulting under fishery conditions. Shading indicates depletions relative to average stock depletion levels over the period 2012-15 (34%$SB_{F=0}$), consistent with CMM 2021-01.

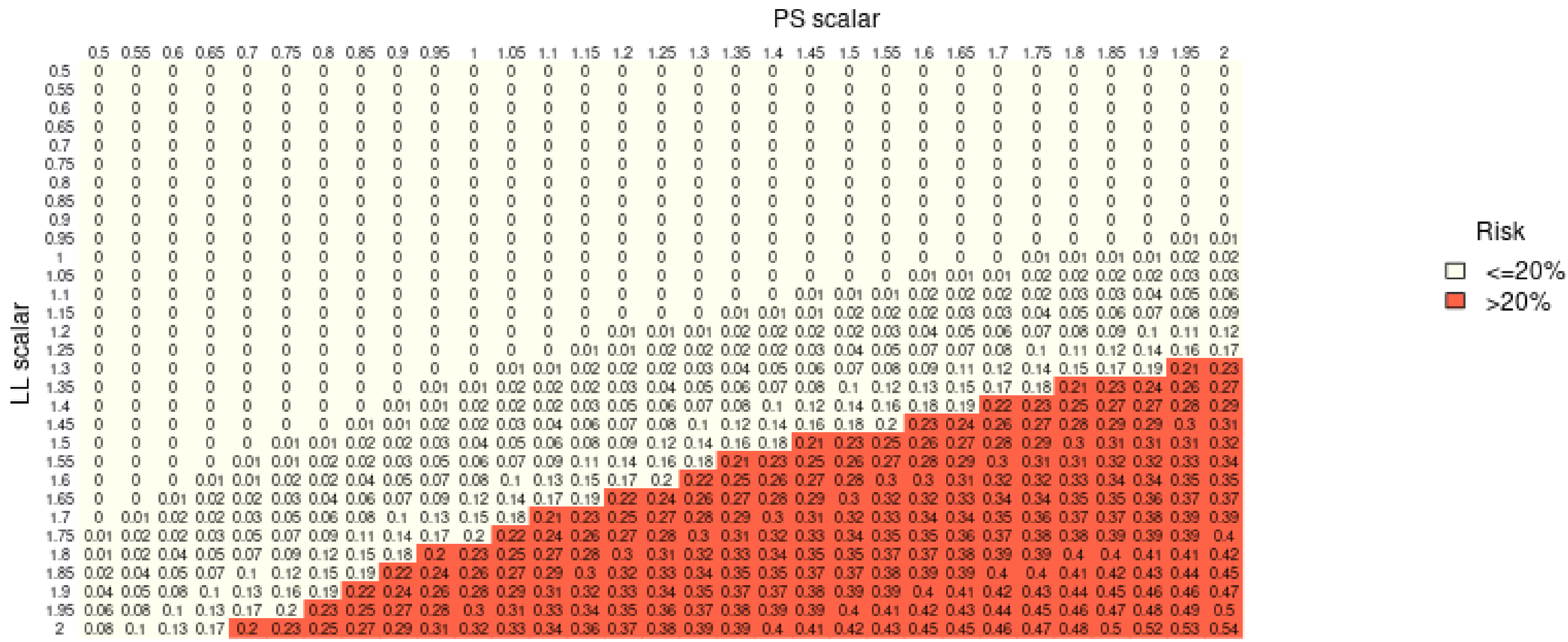


Figure 4. Risk that the bigeye stock depletion levels ($SB/SB_{F=0}$) resulting under the different purse seine (across) and longline (down) scalars (relative to 2019-21 levels), under the assumption that 'long term' recruitment levels continue, will fall below the limit reference point. Values indicate the risk level under those fishery conditions, shading indicates those risk levels less than or equal to, and greater than, 20%.

PS scalar

LL scalar	0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95	1	1.05	1.1	1.15	1.2	1.25	1.3	1.35	1.4	1.45	1.5	1.55	1.6	1.65	1.7	1.75	1.8	1.85	1.9	1.95	2
0.5	0.437	0.428	0.418	0.41	0.402	0.393	0.385	0.377	0.37	0.363	0.356	0.35	0.343	0.336	0.329	0.323	0.316	0.31	0.304	0.298	0.293	0.287	0.282	0.277	0.273	0.268	0.263	0.258	0.254	0.249	0.245
0.55	0.434	0.424	0.416	0.407	0.399	0.39	0.382	0.374	0.367	0.36	0.354	0.347	0.34	0.333	0.326	0.32	0.314	0.307	0.301	0.295	0.29	0.285	0.28	0.275	0.27	0.265	0.26	0.256	0.252	0.247	0.243
0.6	0.431	0.421	0.413	0.403	0.395	0.387	0.379	0.372	0.364	0.358	0.351	0.344	0.337	0.329	0.323	0.317	0.31	0.304	0.298	0.292	0.287	0.282	0.277	0.272	0.268	0.262	0.258	0.254	0.249	0.244	0.24
0.65	0.427	0.419	0.41	0.4	0.392	0.384	0.376	0.369	0.362	0.355	0.348	0.341	0.333	0.327	0.321	0.314	0.308	0.301	0.295	0.29	0.285	0.28	0.274	0.27	0.265	0.26	0.255	0.251	0.246	0.242	0.238
0.7	0.424	0.416	0.406	0.398	0.389	0.381	0.373	0.366	0.359	0.352	0.345	0.338	0.33	0.324	0.318	0.311	0.305	0.299	0.293	0.287	0.282	0.277	0.272	0.267	0.262	0.258	0.253	0.248	0.244	0.24	0.236
0.75	0.422	0.412	0.403	0.395	0.386	0.378	0.37	0.363	0.356	0.349	0.343	0.334	0.328	0.322	0.315	0.308	0.302	0.296	0.29	0.285	0.28	0.275	0.27	0.265	0.26	0.255	0.251	0.246	0.242	0.238	0.233
0.8	0.419	0.409	0.4	0.392	0.383	0.375	0.367	0.36	0.354	0.347	0.339	0.331	0.325	0.319	0.312	0.306	0.299	0.293	0.288	0.282	0.277	0.272	0.267	0.262	0.257	0.253	0.248	0.244	0.24	0.235	0.231
0.85	0.415	0.406	0.397	0.389	0.381	0.373	0.365	0.358	0.351	0.344	0.336	0.329	0.323	0.316	0.309	0.303	0.297	0.291	0.285	0.28	0.275	0.27	0.265	0.26	0.255	0.25	0.246	0.241	0.237	0.233	0.228
0.9	0.412	0.403	0.394	0.386	0.378	0.369	0.362	0.356	0.349	0.341	0.333	0.327	0.32	0.313	0.306	0.3	0.294	0.288	0.283	0.278	0.273	0.268	0.263	0.257	0.252	0.248	0.243	0.239	0.235	0.23	0.226
0.95	0.41	0.4	0.391	0.384	0.375	0.367	0.36	0.353	0.346	0.338	0.331	0.324	0.317	0.31	0.304	0.297	0.291	0.285	0.28	0.275	0.27	0.265	0.26	0.255	0.25	0.245	0.241	0.237	0.232	0.228	0.224
1	0.406	0.397	0.389	0.381	0.372	0.364	0.357	0.35	0.343	0.335	0.328	0.321	0.314	0.308	0.301	0.294	0.288	0.283	0.278	0.273	0.268	0.263	0.258	0.253	0.248	0.243	0.238	0.234	0.23	0.225	0.222
1.05	0.403	0.394	0.386	0.378	0.369	0.361	0.354	0.347	0.339	0.332	0.326	0.319	0.311	0.305	0.298	0.292	0.286	0.281	0.276	0.27	0.265	0.26	0.255	0.25	0.245	0.241	0.236	0.232	0.228	0.223	0.219
1.1	0.401	0.392	0.383	0.374	0.366	0.359	0.352	0.345	0.337	0.33	0.323	0.316	0.309	0.302	0.295	0.289	0.284	0.279	0.273	0.268	0.263	0.258	0.253	0.248	0.243	0.238	0.234	0.229	0.225	0.221	0.217
1.15	0.398	0.389	0.38	0.371	0.364	0.356	0.349	0.342	0.334	0.327	0.32	0.313	0.306	0.299	0.292	0.287	0.282	0.276	0.271	0.265	0.26	0.255	0.25	0.245	0.241	0.236	0.231	0.227	0.223	0.219	0.215
1.2	0.395	0.386	0.378	0.368	0.361	0.353	0.346	0.339	0.332	0.325	0.318	0.31	0.303	0.297	0.29	0.285	0.279	0.274	0.268	0.263	0.258	0.253	0.248	0.243	0.238	0.234	0.229	0.225	0.221	0.216	0.213
1.25	0.393	0.383	0.375	0.366	0.358	0.351	0.344	0.336	0.329	0.322	0.315	0.308	0.301	0.294	0.288	0.283	0.277	0.271	0.266	0.261	0.256	0.25	0.245	0.241	0.236	0.231	0.227	0.223	0.218	0.214	0.211
1.3	0.39	0.381	0.372	0.364	0.356	0.349	0.341	0.334	0.327	0.319	0.312	0.305	0.299	0.292	0.286	0.28	0.274	0.269	0.264	0.258	0.253	0.248	0.243	0.238	0.234	0.229	0.224	0.221	0.216	0.212	0.208
1.35	0.387	0.378	0.369	0.361	0.353	0.346	0.338	0.331	0.324	0.316	0.31	0.303	0.296	0.289	0.283	0.277	0.272	0.267	0.261	0.256	0.251	0.246	0.241	0.236	0.231	0.227	0.222	0.218	0.214	0.21	0.206
1.4	0.384	0.375	0.366	0.359	0.351	0.343	0.335	0.329	0.322	0.313	0.307	0.301	0.293	0.287	0.281	0.275	0.27	0.264	0.259	0.254	0.249	0.243	0.238	0.233	0.229	0.224	0.22	0.216	0.212	0.208	0.204
1.45	0.382	0.372	0.364	0.356	0.349	0.34	0.333	0.326	0.319	0.311	0.305	0.298	0.291	0.284	0.278	0.273	0.267	0.262	0.257	0.251	0.246	0.241	0.236	0.231	0.227	0.222	0.218	0.214	0.21	0.205	0.202
1.5	0.379	0.37	0.361	0.354	0.346	0.338	0.331	0.324	0.316	0.309	0.302	0.295	0.288	0.282	0.276	0.271	0.265	0.26	0.254	0.249	0.244	0.239	0.234	0.229	0.224	0.22	0.216	0.211	0.207	0.203	0.2
1.55	0.377	0.367	0.359	0.351	0.343	0.335	0.328	0.321	0.313	0.307	0.299	0.293	0.286	0.28	0.274	0.268	0.263	0.257	0.252	0.247	0.241	0.236	0.231	0.227	0.222	0.218	0.213	0.209	0.205	0.201	0.198
1.6	0.374	0.365	0.356	0.349	0.34	0.333	0.325	0.318	0.311	0.304	0.297	0.29	0.284	0.277	0.272	0.266	0.26	0.255	0.25	0.245	0.239	0.234	0.229	0.225	0.22	0.216	0.211	0.207	0.203	0.199	0.196
1.65	0.371	0.362	0.354	0.346	0.338	0.33	0.323	0.316	0.308	0.301	0.294	0.288	0.281	0.275	0.269	0.264	0.258	0.253	0.248	0.242	0.237	0.232	0.227	0.222	0.218	0.214	0.209	0.205	0.201	0.197	0.193
1.7	0.368	0.36	0.351	0.343	0.335	0.328	0.32	0.313	0.306	0.298	0.292	0.285	0.278	0.273	0.267	0.261	0.256	0.25	0.245	0.24	0.235	0.229	0.221	0.22	0.216	0.211	0.207	0.203	0.199	0.195	0.191
1.75	0.365	0.357	0.349	0.341	0.333	0.325	0.318	0.311	0.303	0.296	0.29	0.283	0.276	0.27	0.265	0.259	0.253	0.248	0.243	0.238	0.232	0.228	0.223	0.218	0.214	0.209	0.205	0.201	0.197	0.193	0.189
1.8	0.363	0.355	0.346	0.338	0.33	0.323	0.315	0.308	0.301	0.294	0.287	0.28	0.274	0.268	0.262	0.257	0.251	0.246	0.24	0.235	0.23	0.225	0.22	0.216	0.211	0.207	0.203	0.198	0.194	0.19	0.187
1.85	0.36	0.352	0.344	0.336	0.328	0.32	0.313	0.306	0.298	0.291	0.285	0.278	0.272	0.266	0.26	0.254	0.248	0.243	0.238	0.233	0.228	0.223	0.218	0.214	0.209	0.205	0.201	0.196	0.192	0.188	0.184
1.9	0.358	0.35	0.341	0.333	0.325	0.317	0.31	0.303	0.295	0.289	0.282	0.275	0.269	0.263	0.258	0.252	0.246	0.241	0.236	0.231	0.226	0.221	0.216	0.212	0.207	0.203	0.199	0.194	0.19	0.186	0.182
1.95	0.355	0.347	0.339	0.331	0.323	0.315	0.308	0.3	0.293	0.287	0.28	0.273	0.267	0.261	0.255	0.249	0.243	0.238	0.234	0.228	0.223	0.218	0.214	0.209	0.205	0.201	0.196	0.192	0.187	0.184	0.18
2	0.353	0.344	0.336	0.328	0.32	0.312	0.305	0.298	0.291	0.284	0.277	0.271	0.264	0.259	0.253	0.247	0.241	0.236	0.231	0.226	0.221	0.216	0.212	0.207	0.202	0.199	0.194	0.19	0.185	0.181	0.178

>0.44
0.34 to 0.44
0.24 to 0.34
< 0.24

Figure 5. Yellowfin equilibrium stock depletion levels ($SB/SB_{F=0}$) resulting under the different purse seine (across) and longline (down) scalars (relative to 2019-21 levels), under the assumption that 'long term' recruitment levels continue. Values indicate equilibrium depletion levels resulting under fishery conditions. Shading indicates depletions relative to average stock depletion levels over the period 2012-15 (44%$SB_{F=0}$), consistent with CMM 2021-01.

PS scalar

LL scalar	0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95	1	1.05	1.1	1.15	1.2	1.25	1.3	1.35	1.4	1.45	1.5	1.55	1.6	1.65	1.7	1.75	1.8	1.85	1.9	1.95	2
0.5	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0.02	0.03	0.03	0.05	0.06	0.07	0.08	0.1	0.11	0.14	0.15	0.16	0.19	0.21	0.22	0.23	0.26	0.28
0.55	0	0	0	0	0	0	0	0	0	0	0	0.01	0.02	0.03	0.03	0.04	0.05	0.06	0.08	0.09	0.11	0.13	0.15	0.16	0.18	0.2	0.22	0.23	0.25	0.27	0.29
0.6	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0.02	0.03	0.03	0.05	0.06	0.07	0.09	0.1	0.12	0.14	0.15	0.17	0.19	0.22	0.23	0.24	0.26	0.29	0.31
0.65	0	0	0	0	0	0	0	0	0	0	0.01	0.02	0.03	0.03	0.04	0.05	0.07	0.08	0.09	0.11	0.13	0.15	0.16	0.19	0.21	0.22	0.23	0.26	0.28	0.3	0.32
0.7	0	0	0	0	0	0	0	0	0	0.01	0.01	0.02	0.03	0.03	0.05	0.06	0.07	0.09	0.1	0.12	0.14	0.15	0.17	0.2	0.22	0.23	0.25	0.26	0.29	0.31	0.33
0.75	0	0	0	0	0	0	0	0	0	0.01	0.02	0.03	0.03	0.04	0.05	0.07	0.08	0.09	0.11	0.13	0.15	0.16	0.19	0.21	0.22	0.24	0.26	0.28	0.31	0.32	0.34
0.8	0	0	0	0	0	0	0	0	0.01	0.01	0.02	0.03	0.03	0.05	0.06	0.07	0.09	0.11	0.12	0.14	0.16	0.18	0.2	0.22	0.23	0.25	0.27	0.3	0.31	0.33	0.35
0.85	0	0	0	0	0	0	0	0	0.01	0.02	0.03	0.03	0.04	0.05	0.07	0.08	0.09	0.11	0.13	0.15	0.17	0.19	0.21	0.23	0.25	0.27	0.29	0.31	0.33	0.34	0.36
0.9	0	0	0	0	0	0	0	0.01	0.01	0.02	0.03	0.03	0.05	0.06	0.07	0.09	0.11	0.12	0.14	0.16	0.18	0.21	0.22	0.24	0.26	0.28	0.3	0.32	0.34	0.35	0.38
0.95	0	0	0	0	0	0	0	0.01	0.02	0.03	0.03	0.04	0.05	0.07	0.08	0.1	0.12	0.13	0.15	0.17	0.2	0.21	0.23	0.25	0.27	0.29	0.31	0.33	0.34	0.37	0.39
1	0	0	0	0	0	0	0.01	0.01	0.02	0.03	0.03	0.05	0.06	0.07	0.09	0.11	0.12	0.14	0.16	0.19	0.21	0.22	0.24	0.26	0.28	0.3	0.32	0.34	0.36	0.39	0.4
1.05	0	0	0	0	0	0	0.01	0.02	0.03	0.03	0.04	0.05	0.06	0.08	0.1	0.12	0.13	0.15	0.17	0.2	0.22	0.23	0.25	0.27	0.29	0.32	0.33	0.35	0.37	0.39	0.42
1.1	0	0	0	0	0	0.01	0.01	0.02	0.03	0.03	0.04	0.06	0.07	0.09	0.11	0.12	0.14	0.16	0.19	0.21	0.22	0.25	0.26	0.28	0.31	0.33	0.34	0.36	0.39	0.4	0.43
1.15	0	0	0	0	0	0.01	0.02	0.02	0.03	0.03	0.05	0.06	0.08	0.1	0.12	0.13	0.15	0.18	0.2	0.22	0.23	0.25	0.28	0.29	0.32	0.34	0.35	0.38	0.4	0.42	0.44
1.2	0	0	0	0	0	0.01	0.02	0.03	0.03	0.04	0.06	0.07	0.09	0.11	0.13	0.14	0.16	0.19	0.21	0.23	0.25	0.26	0.29	0.31	0.33	0.34	0.37	0.39	0.41	0.43	0.45
1.25	0	0	0	0	0.01	0.01	0.02	0.03	0.03	0.05	0.06	0.08	0.1	0.11	0.13	0.15	0.18	0.2	0.22	0.23	0.26	0.28	0.3	0.32	0.34	0.36	0.39	0.4	0.42	0.44	0.46
1.3	0	0	0	0	0.01	0.02	0.03	0.03	0.04	0.06	0.07	0.08	0.11	0.13	0.14	0.16	0.19	0.21	0.23	0.25	0.26	0.28	0.31	0.33	0.35	0.37	0.39	0.41	0.43	0.46	0.47
1.35	0	0	0	0.01	0.01	0.02	0.03	0.03	0.05	0.06	0.08	0.09	0.11	0.13	0.15	0.18	0.2	0.22	0.24	0.26	0.28	0.3	0.32	0.34	0.36	0.39	0.4	0.42	0.44	0.47	0.48
1.4	0	0	0	0.01	0.02	0.03	0.03	0.04	0.05	0.06	0.08	0.1	0.12	0.14	0.16	0.19	0.21	0.23	0.25	0.27	0.28	0.31	0.33	0.35	0.38	0.4	0.41	0.44	0.46	0.47	0.49
1.45	0	0	0	0.01	0.02	0.03	0.03	0.04	0.06	0.07	0.09	0.11	0.13	0.15	0.18	0.2	0.22	0.24	0.26	0.28	0.3	0.32	0.34	0.36	0.39	0.4	0.43	0.45	0.47	0.48	0.5
1.5	0	0	0.01	0.01	0.02	0.03	0.03	0.05	0.06	0.08	0.1	0.12	0.14	0.17	0.19	0.21	0.23	0.25	0.27	0.28	0.31	0.33	0.35	0.38	0.4	0.41	0.44	0.46	0.48	0.49	0.51
1.55	0	0	0.01	0.02	0.03	0.03	0.04	0.06	0.07	0.09	0.11	0.13	0.15	0.18	0.2	0.22	0.24	0.26	0.28	0.3	0.32	0.34	0.36	0.39	0.4	0.43	0.45	0.47	0.49	0.5	0.52
1.6	0	0	0.01	0.02	0.03	0.03	0.05	0.06	0.08	0.1	0.12	0.14	0.16	0.18	0.21	0.23	0.25	0.27	0.29	0.31	0.34	0.35	0.38	0.4	0.42	0.44	0.46	0.48	0.5	0.51	0.53
1.65	0	0.01	0.02	0.02	0.03	0.04	0.05	0.07	0.09	0.11	0.13	0.15	0.17	0.19	0.22	0.24	0.26	0.28	0.3	0.32	0.34	0.37	0.39	0.4	0.43	0.45	0.47	0.49	0.5	0.52	0.54
1.7	0	0.01	0.02	0.03	0.03	0.04	0.06	0.08	0.09	0.12	0.14	0.16	0.18	0.21	0.23	0.25	0.26	0.29	0.31	0.33	0.35	0.38	0.41	0.42	0.44	0.46	0.48	0.5	0.51	0.53	0.55
1.75	0.01	0.01	0.02	0.03	0.04	0.05	0.07	0.09	0.1	0.13	0.15	0.17	0.19	0.22	0.24	0.26	0.28	0.3	0.32	0.34	0.37	0.39	0.4	0.43	0.46	0.47	0.49	0.51	0.52	0.54	0.56
1.8	0.01	0.02	0.03	0.03	0.04	0.06	0.07	0.09	0.12	0.14	0.16	0.18	0.2	0.22	0.24	0.26	0.29	0.31	0.33	0.35	0.38	0.4	0.42	0.44	0.46	0.48	0.5	0.52	0.53	0.55	0.57
1.85	0.01	0.02	0.03	0.03	0.05	0.06	0.08	0.1	0.12	0.14	0.17	0.19	0.21	0.24	0.26	0.27	0.3	0.32	0.34	0.37	0.39	0.4	0.43	0.45	0.47	0.49	0.51	0.52	0.54	0.56	0.57
1.9	0.01	0.02	0.03	0.04	0.05	0.07	0.09	0.11	0.13	0.15	0.18	0.2	0.22	0.24	0.26	0.29	0.31	0.33	0.35	0.38	0.4	0.42	0.44	0.46	0.48	0.5	0.52	0.53	0.55	0.57	0.58
1.95	0.02	0.03	0.03	0.04	0.06	0.08	0.1	0.12	0.14	0.16	0.19	0.21	0.23	0.25	0.27	0.3	0.32	0.34	0.37	0.39	0.4	0.43	0.45	0.47	0.49	0.51	0.52	0.54	0.56	0.58	0.59
2	0.02	0.03	0.03	0.05	0.07	0.08	0.11	0.13	0.15	0.18	0.2	0.22	0.24	0.26	0.28	0.31	0.33	0.35	0.38	0.39	0.42	0.44	0.46	0.48	0.5	0.52	0.53	0.55	0.57	0.58	0.6

Risk
<=20%
>20%

Figure 6. Risk that the yellowfin stock depletion levels ($SB/SB_{F=0}$) resulting under the different purse seine (across) and longline (down) scalars (relative to 2019-21 levels), under the assumption that 'long term' recruitment levels continue, will fall below the limit reference point. Values indicate the risk level under those fishery conditions, shading indicates those risk levels less than or equal to, and greater than, 20%.

Preliminary updated evaluation of CMM 2021-01

SC19 requested an update of the evaluation of CMM 2021-01 be provided to the 4th TTMW. The SSP has therefore prioritised this work and has specifically updated the results of WCPFC19-2022-13_rev1 Tables 1 and 2 as far as possible with the results available.

New baseline periods are used within the re-evaluation, being the last three years (2019-2021) in all three stock assessments (bigeye, skipjack and yellowfin). This simplifies some calculations as the CMM 2021-01 FAD closure period of 3 months + 2 additional months in the high seas was in operation across all three of those years. Four scenarios are examined, being 'optimistic', where fishing opportunities available under the CMM (e.g. the high seas effort limits in CMM2021-01) are not maximised, and essentially fishing levels are comparable to the 2019-2021 period; 'SKJ MP', where overall purse seine effort is set at the 2012 baseline effort level defined by the output of the skipjack MP (see also response to request #5) and where longline fishing opportunities are taken from either of the other two scenarios; and 'fully utilised', where all fishing opportunities available under the CMM are taken (including for purse seine the additional potential FAD sets consistent with the high seas effort limits in CMM 2021-01 (CMM Table 2)) and purse seine effort is as specified by the skipjack MP. Scalars change to reflect the new 2019-2021 baselines. This update is presented in Table 1 and Table 2. The evolution of the projected bigeye and yellowfin stock depletion under the different CMM evaluation scenarios is shown in Figure 7 and Figure 8. A paper with a full CMM 2021-01 re-evaluation will be provided to WCPFC20.

Note we have not considered fishing levels nominated in CMM 2021-01 Table 1 within the 'fully utilised' scenario as it requires considerable assumptions to be made on FAD set patterns to convert days in areas where limited fishing has historically occurred into estimated FAD sets. For indication, the implications of full utilisation of CMM Table 1 and 2 effort (using the calculations in WCPFC-SC11-2015/ MI-WP-10 as a basis) implies a purse seine effort scalar (only) of *approximately* 1.45.

Table 1. Median values of reference point levels (adopted limit reference point (LRP) of 20% $SB_{F=0}$; F_{MSY}) and risk[1] of breaching reference points from the 2023 assessment of WCPO bigeye tuna, and in 2051 under three future harvest scenarios (optimistic, SKJ MP, and fully utilised) and alternative recruitment hypotheses.

Scenario		Scalars relative to 2019-2021		Median $SB_{2051}/SB_{F=0}$	Median $SB_{2051}/SB_{F=0}$ v $SB_{2012\text{-}15}/SB_{F=0}$	Median $F_{2047\text{-}2050}/F_{MSY}$	Median ratio $F_{2047\text{-}2050}/F_{MSY}$ v $F_{2017\text{-}20}/F_{MSY}$	Risk (%)[1]	
Recruitment	Fishing level	Purse seine	Longline					$SB_{2051}<LRP$	$F>F_{MSY}$
Recent	Optimistic[2]	1	1	0.46	1.35	*TBC*	*TBC*	0%	*TBC*
	SKJ MP	1.19	1	0.43	1.27	*TBC*	*TBC*	0%	*TBC*
		1.19	1.66[3]	0.34	0.99	*TBC*	*TBC*	0%	TBC
	Fully utilised	1.22	1.66[3]	0.33	0.97	*TBC*	*TBC*	0%	*TBC*
Long-term	Optimistic[2]	1	1	0.43	1.26	*TBC*	*TBC*	0%	*TBC*
	SKJ MP	1.19	1	0.41	1.19	*TBC*	*TBC*	0%	*TBC*
		1.19	1.66[3]	0.30	0.88	*TBC*	*TBC*	22%	*TBC*
	Fully utilised	1.22	1.66[3]	0.29	0.85	*TBC*	*TBC*	24%	*TBC*

[1] Risk within the stock assessment is calculated as the (weighted – if weights applied) number of models falling below the LRP (X / No. models). Risk under a projection scenario is the number of projections across the grid that fall below the LRP (X / (No. models x 20 projections) in the terminal projection year (2051).

[2] As the purse seine FAD closure period over 2019-2021 is equivalent to that specified within CMM 2021-01, and longline catches over that period are below limits within the CMM, the optimistic scenario off the 2019-2021 baseline is a scalar of 1 for both gears.

[3] includes Canadian limits, as requested by WCPFC17.

Table 2. Median values of reference point levels (adopted limit reference point (LRP) of 20% $SB_{F=0}$; F_{MSY}) and risk[1] of breaching reference points from the 2022 WCPO skipjack and 2023 assessment of WCPO yellowfin tuna, and in 2051 under the three future harvest scenarios (optimistic, SKJ MP, and fully utilised) and alternative recruitment hypotheses.

Stock	Fishing level	Scalars relative to 2019-2021		Median $SB_{2051}/SB_{F=0}$	Median $SB_{2051}/SB_{F=0}$ v $SB_{2012-15}/SB_{F=0}$	Median $F_{2047-2050}/F_{MSY}$	Median ratio $F_{2047-2050}/F_{MSY}$ v $F_{2017-20}/F_{MSY}$	Risk (%)	
		Purse seine	Longline					SB_{2051}<LRP	$F>F_{MSY}$
Yellowfin	Optimistic	1	1	0.33	0.74	*TBC*	*TBC*	3%	*TBC*
	SKJ MP/Fully utilised	1.19	1.66	0.27	0.61	*TBC*	*TBC*	22%	*TBC*
					Median $SB_{2051}/SB_{F=0}$ v $SB/SB_{F=0}$ = 0.50				
Skipjack	Optimistic	1	1	0.53	1.07	0.31	0.97	0%	0%
	SKJ MP/Fully utilised	1.19	1.66	0.50	1	0.35	1.09	0%	2%

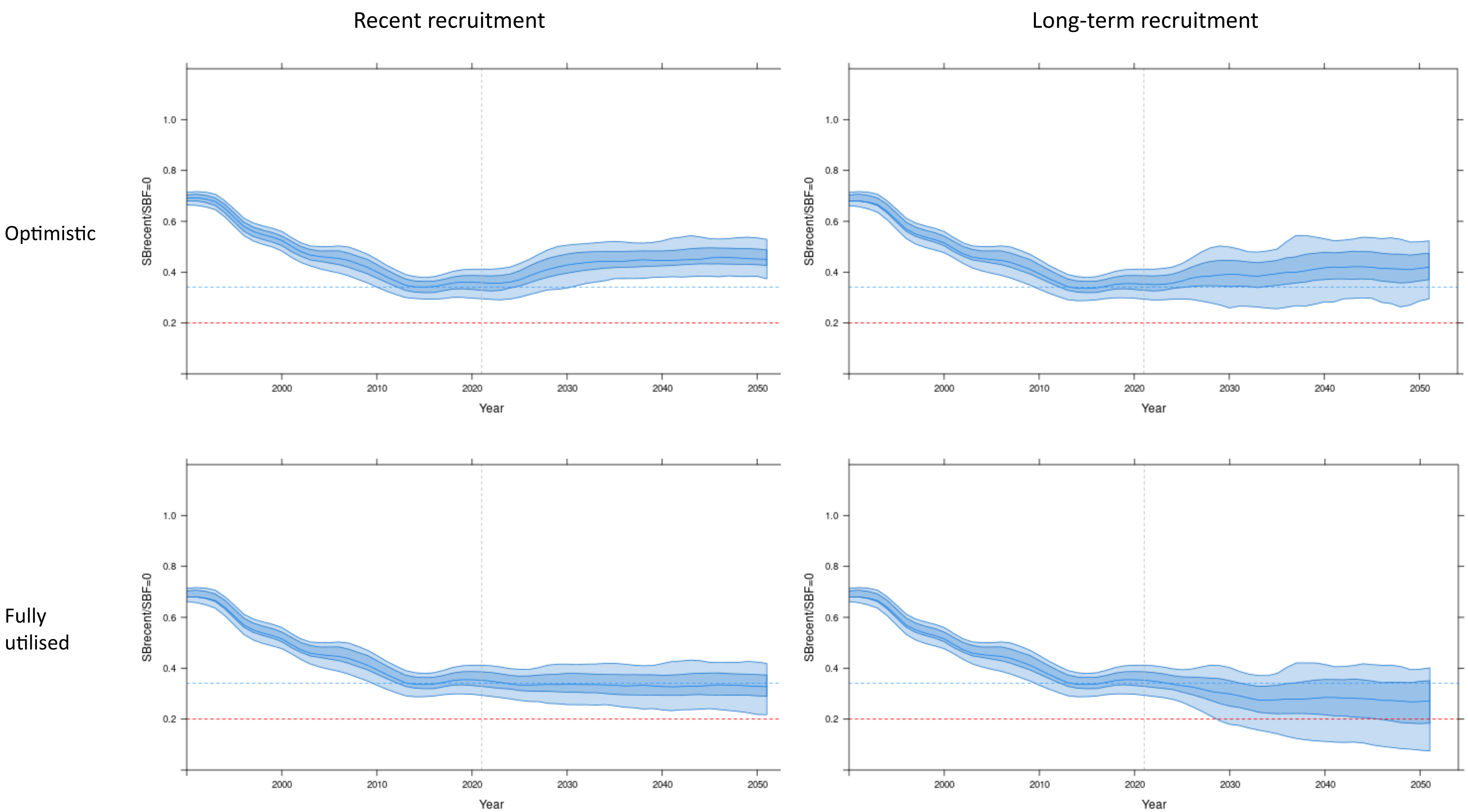


Figure 7. Time series of WCPO bigeye tuna spawning biomass ($SB_{recent}/SB_{F=0}$) from the uncertainty grid of assessment model runs for the period 1990 to 2021 (the vertical line at 2021 represents the last year of the assessment), and stochastic projection results for the period 2022 to 2051 under two future fishing scenarios ('Optimistic' and 'Fully utillised'; rows). During the projection period (2021-2051) levels of recruitment variability are assumed to match those over the "recent" time period (2011-2020; left panel) or the time period used to estimate the stock-recruitment relationship (1962-2020; right panel). The red dashed line represents the agreed limit reference point, the blue dashed line the 2012-2015 average depletion level.

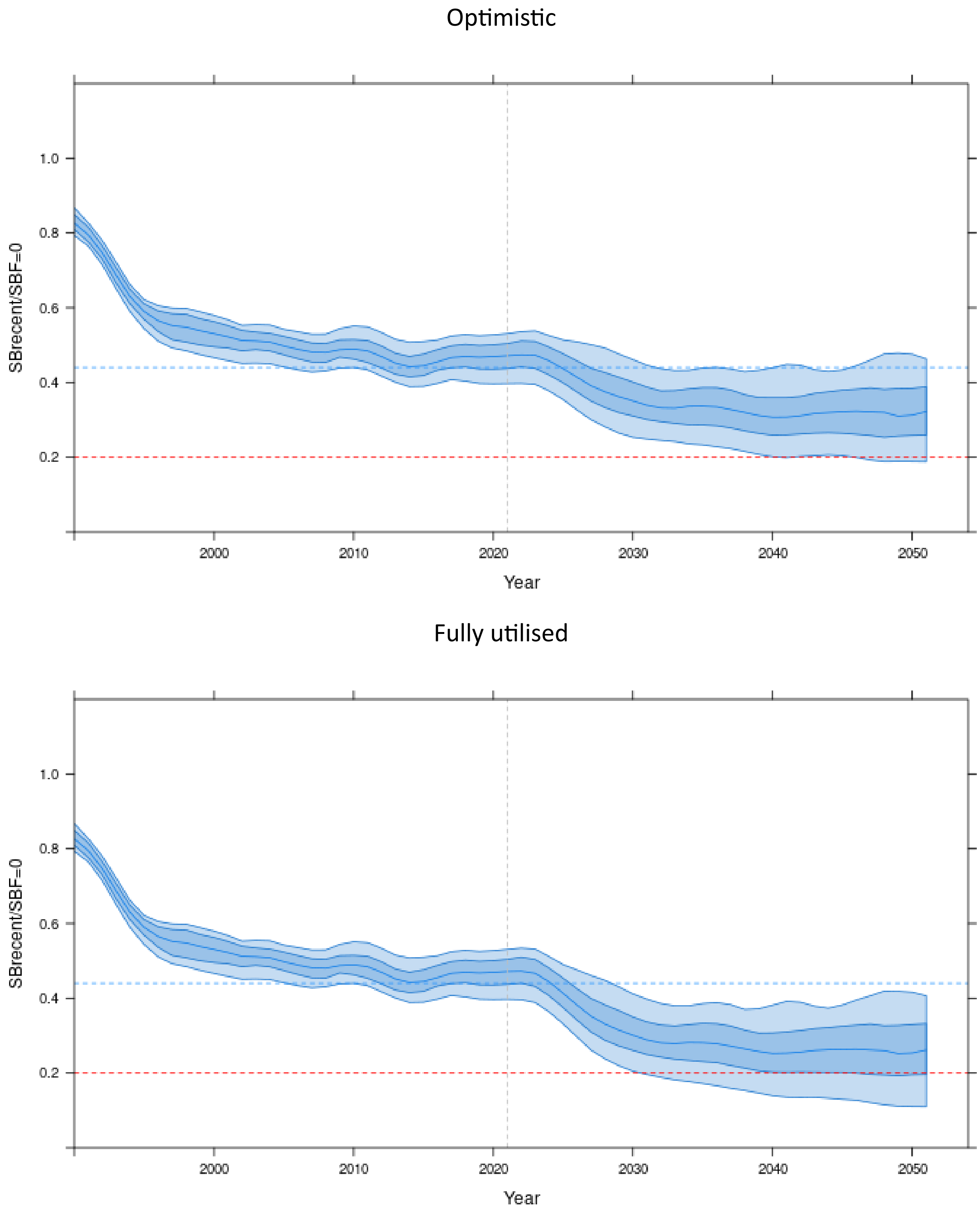


Figure 8. Time series of WCPO yellowfin tuna spawning biomass ($SB_{recent}/SB_{F=0}$) from the uncertainty grid of assessment model runs for the period 1990 to 2021 (the vertical line at 2021 represents the last year of the assessment), and stochastic projection results for the period 2022 to 2051 under two future fishing scenarios ('Optimistic' and 'Fully utillised'). During the projection period (2021-2051) levels of recruitment variability are assumed to match those over the "recent" time period (2011-2020; left panel) or the time period used to estimate the stock-recruitment relationship (1962-2020; right panel). The red dashed line represents the agreed limit reference point, the blue dashed line the 2012-2015 average depletion level.

2 Trade-off between bigeye longline catch and the FAD closure period

As per WCPFC18-2021-15, this trade-off request was interpreted in two ways.

The first component evaluated the level of change required in one gear, relative to 2019-2021 baseline conditions, to maintain the depletion of bigeye tuna (under the two recruitment scenarios) at a specific level. For this analysis, the bigeye stock depletion level of average 2012-2015 depletion was used (CMM objective), to reflect the differing impacts of the recruitment assumptions being examined on future stock productivity. This therefore mirrored a specific 'diagonal line' of Figure 1 and Figure 3 (maintaining BET depletion at 0.34 $SB_{F=0}$ for 'recent' and 'long-term' recruitment scenarios, respectively). The request indicated increases in longline catch, so additional catch increments of 6,000 mt (approximately 10% of the 2019-2021 average) were evaluated, up to a set of scalars that fell within the range examined under request #1.

The approach identifies trade-offs in terms of the impact on the bigeye stock, i.e. maintaining the stock at specific depletion levels, to best reflect the differential impacts purse seine and longline fishing have on that stock. An approach that equated to the impact in terms of equal catch, for example, would ignore the fact that to take a comparable level of catch (mt), the longline fleet would take fewer and larger fish given its selectivity, and hence would have a different impact on the stock to the removal of an equivalent weight of smaller fish by the purse seine fishery.

The approximate equivalent FAD closure period is calculated as equal in zone/high seas FAD closure periods. This uses the results from request #5 to first identify the number of sets estimated to be removed by a theoretical 3 month combined in-zone and high seas closure compared to the theoretical number of sets that would be present where there was no FAD closure at all (in EEZs or high seas), to identify the average FAD sets removed by a single month closure. The current 3 month EEZ + 5 month high seas closure is approximately equivalent to a 3.3 month equal EEZ/HS closure. The approximate additional months of closure (EEZ + HS) are estimated using the scalars provided in Table 8 and Table 9.

The original request asked for the corresponding impacts on yellowfin and skipjack stocks. An assumption of this evaluation is that overall purse seine effort remains constant at 2019-2021 levels, with increased FAD closure duration equating to an increased number of sets being transferred to free school sets to maintain the overall effort. Under this assumption there is no differential impact on skipjack tuna, and hence the consequences for this stock are not presented. For yellowfin, this assumption means that the main impact is through the change in longline catch. For this analysis, the simplifying assumption is made that changes in yellowfin longline catch are equal to the assumed change in bigeye longline catch. Under that strong assumption, the consequences for yellowfin are included within Table 3 and Table 4.

Table 3. Evaluation of the change in FAD sets (and equivalent FAD closure period) required to maintain bigeye depletion at 2012-2015 average levels given set increases in longline bigeye catch, where 'recent' recruitment is assumed. Potential consequences for the yellowfin stock where changes in longline catch mirror those for bigeye are shown.

Approximate LL BET catch (mt)	LL scalar from 2016-18 average	LL scalar from 2019-21 average	Scalar for PS FAD sets to maintain BET at '2012-2015' depletion levels	Approximate equivalent additional months of PS FAD closure period (and approx. total*)	Resulting yellowfin $SB/SB_{F=0}$
65,000	1.11	1.16	2	-8.6 (0)	0.32
71,000	1.19	1.25	1.8	-6.9 (0)	0.31
77,000	1.31	1.37	1.7	-6.0 (0)	0.31
83,000	1.42	1.48	1.5	-4.3 (0)	0.30
89,000	1.52	1.59	1.25	-2.2 (1.2)	0.29
95,000	1.62	1.69	1.1	-0.9 (2.4)	0.29
101,000	1.72	1.80	1	0 (3.30)	0.29
107,000	1.83	1.91	0.9	0.9 (4.2)	0.27

* assumes approximate average FAD closure period of 3.3 months over 2019-2021

Table 4. Evaluation of the change in FAD sets (and approximate equivalent FAD closure period) required to maintain bigeye depletion at 2012-2015 average levels given set increases in longline bigeye catch, where 'long-term' recruitment is assumed. Potential consequences for the yellowfin stock where changes in longline catch mirror those for bigeye are shown.

Approximate LL BET catch (mt)	LL scalar from 2016-18 average	LL scalar from 2019-21 average	Scalar for PS FAD sets to maintain BET at '2012-2015' depletion levels	Approximate equivalent additional months of PS FAD closure period (and approx. total*)	Resulting yellowfin $SB/SB_{F=0}$
65,000	1.11	1.16	1.6	-5.2 (0)	0.32
71,000	1.19	1.25	1.4	-3.4 (0)	0.31
77,000	1.31	1.37	1.2	-1.7 (1.6)	0.31
83,000	1.42	1.48	1.05	-0.4 (2.9)	0.30
89,000	1.52	1.59	0.9	0.9 (4.2)	0.29
95,000	1.62	1.69	0.8	1.7 (5.0)	0.29
101,000	1.72	1.80	0.7	2.6 (5.9)	0.29
107,000	1.83	1.91	0.65	3.0 (6.3)	0.27

* assumes approximate average FAD closure period of 3.3 months over 2019-2021

The second component evaluated the length of FAD closure that would have an equivalent impact on the bigeye stock as a specified increase in longline catch. To examine this, the impact of the specified change in longline catch in terms of bigeye depletion was evaluated, assuming the purse seine effort remained at the 2019-2021 average level. Then the corresponding change in purse seine FAD effort required to achieve the same level of bigeye depletion was identified, assuming longline catch remained at the 2019-2021 average level. This was evaluated under 'recent' and 'long-term' recruitment scenarios (Table 5). As the FAD closure was the focus, the implications were evaluated for bigeye only (under the assumption that overall purse seine effort remains constant, results for yellowfin would be as detailed in Table 4).

Table 5. Evaluation of the equivalent change in FAD sets (and approximate equivalent FAD closure period) that had the same impact on bigeye stock depletion as set increases in longline bigeye catch, under 'recent' and 'long-term' recruitment assumptions.

Approximate LL BET catch (mt)	LL scalar from 2016-18 average	LL scalar from 2019-21 average	Resulting bigeye tuna depletion ($SB/SB_{F=0}$)		Equivalent purse seine effort scalar (and approx. total FAD closure duration*)	
			Recent recruitment	Long term recruitment	Recent recruitment	Long term recruitment
65,000	1.11	1.16	0.43	0.40	1.2 (1.6)	1.25 (1.2)
71,000	1.19	1.25	0.42	0.39	1.3 (0.7)	1.35 (0.3)
77,000	1.31	1.37	0.40	0.37	1.5 (0)	1.55 (0)
83,000	1.42	1.48	0.39	0.35	1.65 (0)	1.8 (0)
89,000	1.52	1.59	0.37	0.33	1.9 (0)	>2 (0)
95,000	1.62	1.69	0.36	0.32	>2 (0)	>2 (0)
101,000	1.72	1.80	0.34	0.30	>2 (0)	>2 (0)
107,000	1.83	1.91	0.33	0.28	>2 (0)	>2 (0)

* assumes approximate average FAD closure period of 3.3 months over 2019-2021

3 Biomass depletion levels associated with various candidate TRPs and corresponding LL/PS scalars

Using the results of the 2023 bigeye stock assessment, the average level of depletion corresponding to that within the specified alternative historical periods was identified (Table 6). Different combinations of purse seine effort and longline catch can achieve slightly different depletion levels that result in a given level of risk, due to the different combinations of stock selectivity. We therefore do not include specific values in Table 6. The different combinations of purse seine effort and longline catch that achieve the different TRP levels are presented in Figure 9 to Figure 12. Specific scalar combinations that achieve these depletion levels can be identified using the spreadsheet associated with this paper (filtering on the desired depletion or risk level).

Table 6. Alternative candidate TRP depletion levels for WCPO bigeye tuna.

Candidate TRP	Bigeye $SB/SB_{F=0}$
2012-2015 depletion	0.34
2004 depletion	0.48
2001-2004 depletion	0.46
Depletion consistent with 20% risk	-
Depletion consistent with 10% risk	-

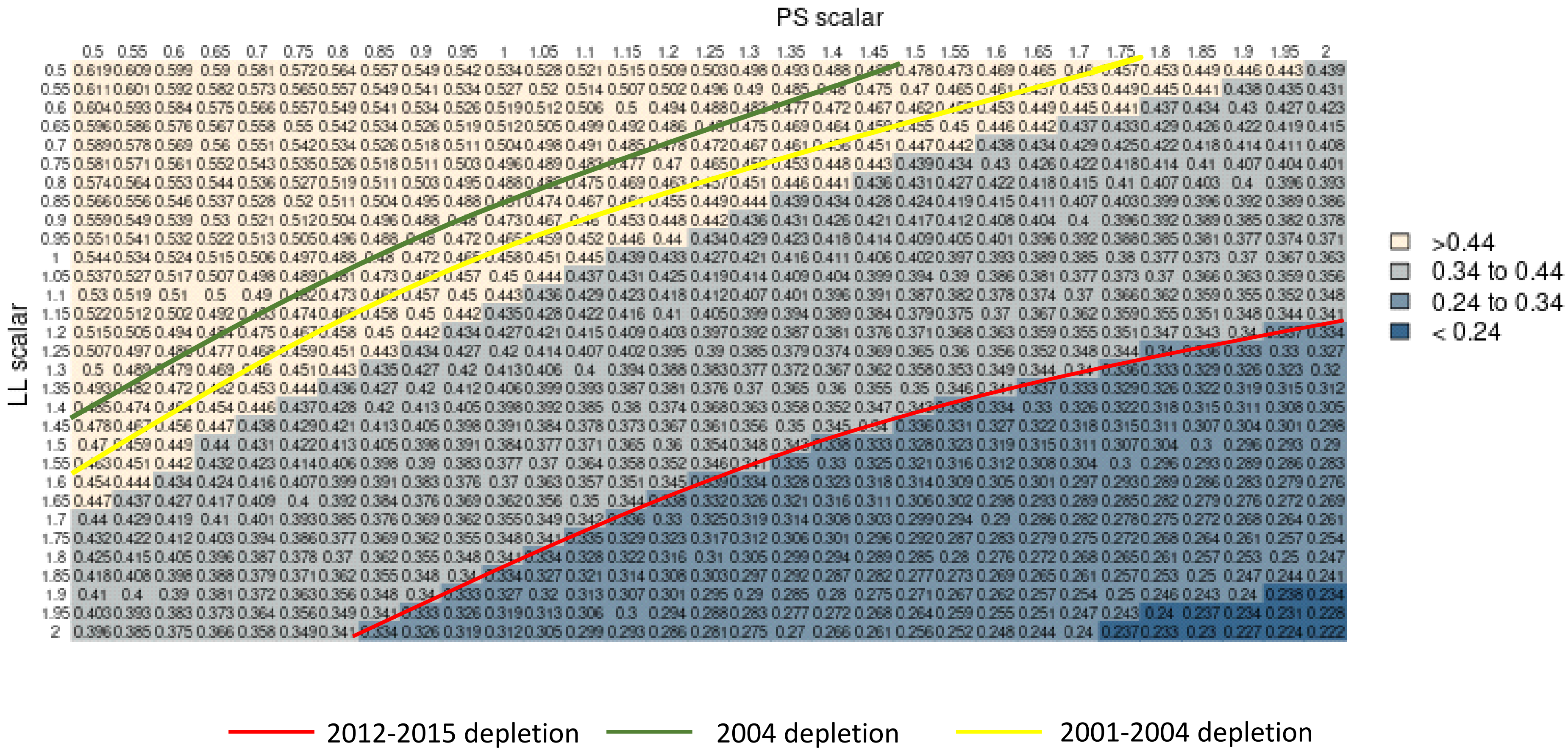


Figure 9. Bigeye equilibrium stock depletion levels ($SB/SB_{F=0}$) resulting under the different purse seine (across) and longline (down) scalars (relative to 2019-21 levels), under the assumption that 'recent' recruitment levels continue. Scalar combinations consistent with levels in Table 6 indicated by the different coloured curves.

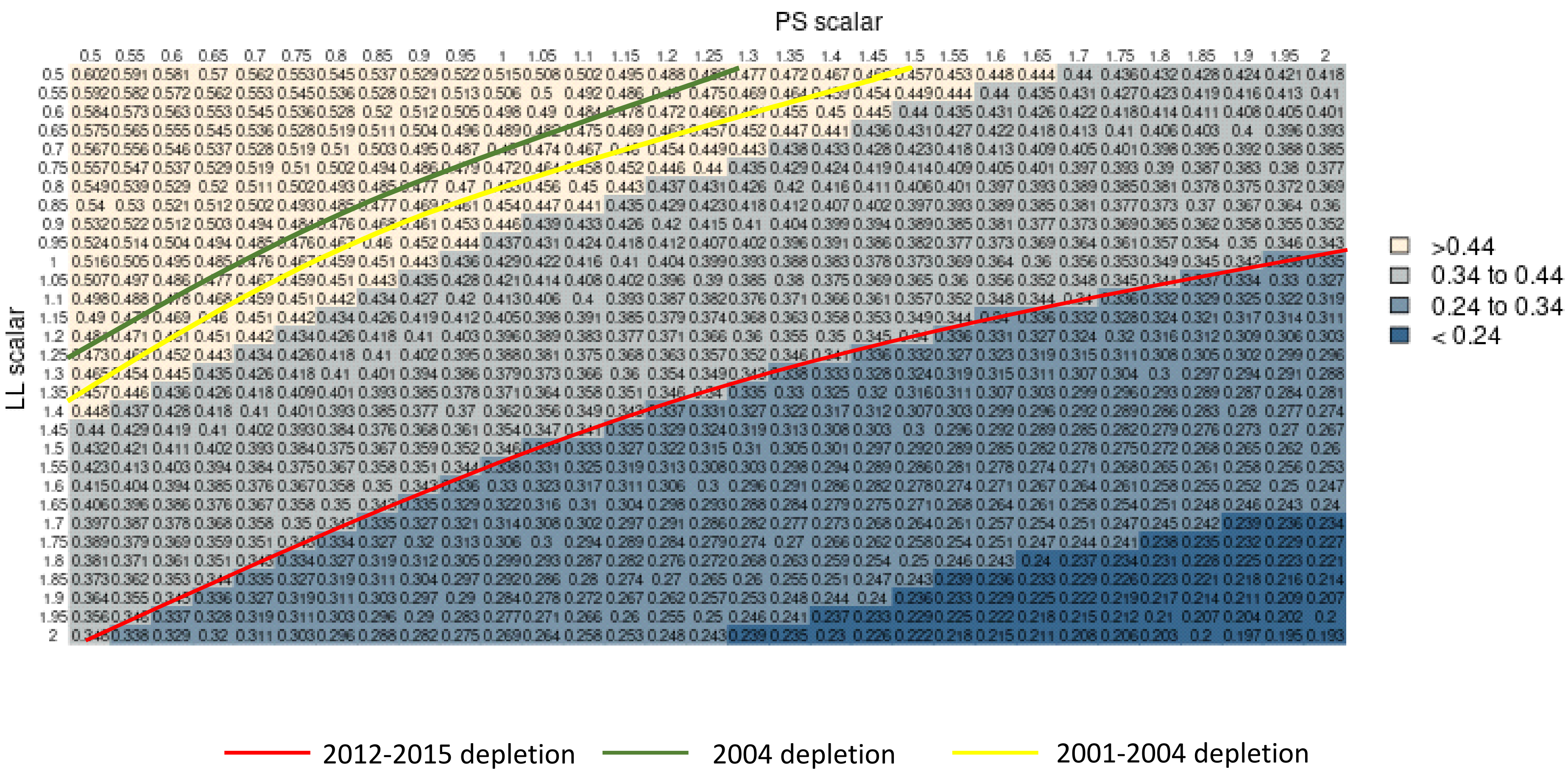
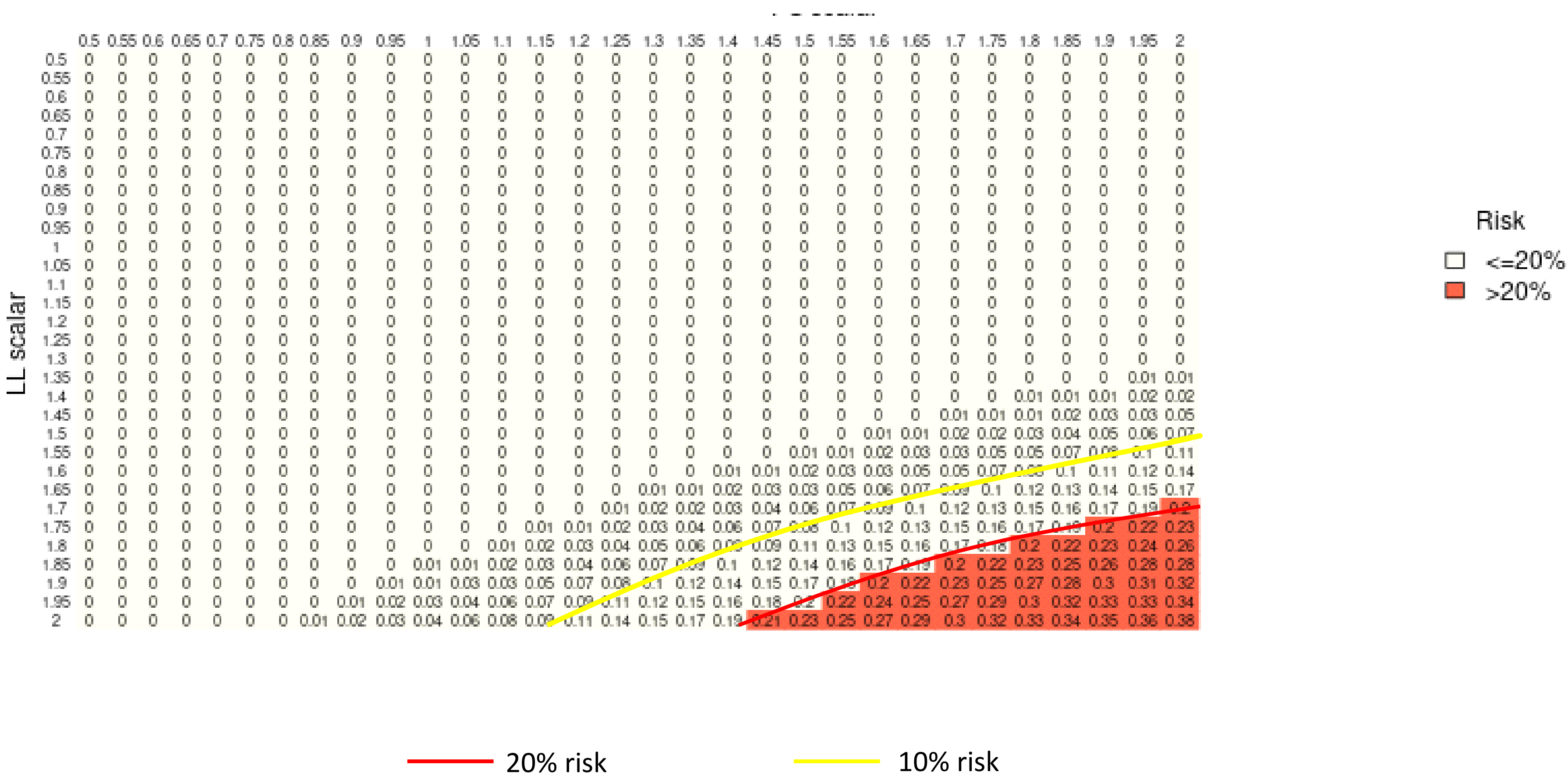


Figure 10. Bigeye equilibrium stock depletion levels ($SB/SB_{F=0}$) resulting under the different purse seine (across) and longline (down) scalars (relative to 2019-21 levels), under the assumption that 'long term' recruitment levels continue. Scalar combinations consistent with levels in Table 6 indicated by the different coloured curves.



LL scalar	0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95	1	1.05	1.1	1.15	1.2	1.25	1.3	1.35	1.4	1.45	1.5	1.55	1.6	1.65	1.7	1.75	1.8	1.85	1.9	1.95	2
0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01
1.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0.01	0.02	0.02
1.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0.01	0.02	0.03	0.03	0.05
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.07
1.55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0.02	0.03	0.03	0.05	0.05	0.07	[illegible]	0.1	0.11
1.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0.02	0.03	0.03	0.05	0.05	0.07	[illegible]	0.1	0.11	0.12	0.14
1.65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0.02	0.03	0.03	0.05	0.06	0.07	[illegible]	0.1	0.12	0.13	0.14	0.15	0.17
1.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.02	0.02	0.03	0.04	0.06	0.07	[illegible]	0.1	0.12	0.13	0.15	0.16	0.17	0.19	0.2
1.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0.02	0.03	0.04	0.06	0.07	[illegible]	0.1	0.12	0.13	0.15	0.16	0.17	[illegible]	0.2	0.22	0.23
1.8	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.02	0.03	0.04	0.05	0.06	[illegible]	0.09	0.11	0.13	0.15	0.16	0.17	0.18	0.2	0.22	0.23	0.24	0.26
1.85	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0.02	0.03	0.04	0.06	0.07	[illegible]	0.1	0.12	0.14	0.16	0.17	[illegible]	0.2	0.22	0.23	0.25	0.26	0.28	0.28
1.9	0	0	0	0	0	0	0	0	0	0.01	0.01	0.03	0.03	0.05	0.07	0.08	0.1	0.12	0.14	0.15	0.17	[illegible]	0.2	0.22	0.23	0.25	0.27	0.28	0.3	0.31	0.32
1.95	0	0	0	0	0	0	0	0	0.01	0.02	0.03	0.04	0.06	0.07	[illegible]	0.11	0.12	0.15	0.16	0.18	0.2	0.22	0.24	0.25	0.27	0.29	0.3	0.32	0.33	0.33	0.34
2	0	0	0	0	0	0	0	0.01	0.02	0.03	0.04	0.06	0.08	[illegible]	0.11	0.14	0.15	0.17	0.19	0.21	0.23	0.25	0.27	0.29	0.3	0.32	0.33	0.34	0.35	0.36	0.38

Figure 11. Risk that the bigeye stock depletion levels ($SB/SB_{F=0}$) resulting under the different purse seine (across) and longline (down) scalars (relative to 2019-21 levels), under the assumption that 'recent' recruitment levels continue, will fall below the limit reference point. Scalar combinations consistent with levels in Table 6 indicated by the different coloured curves.

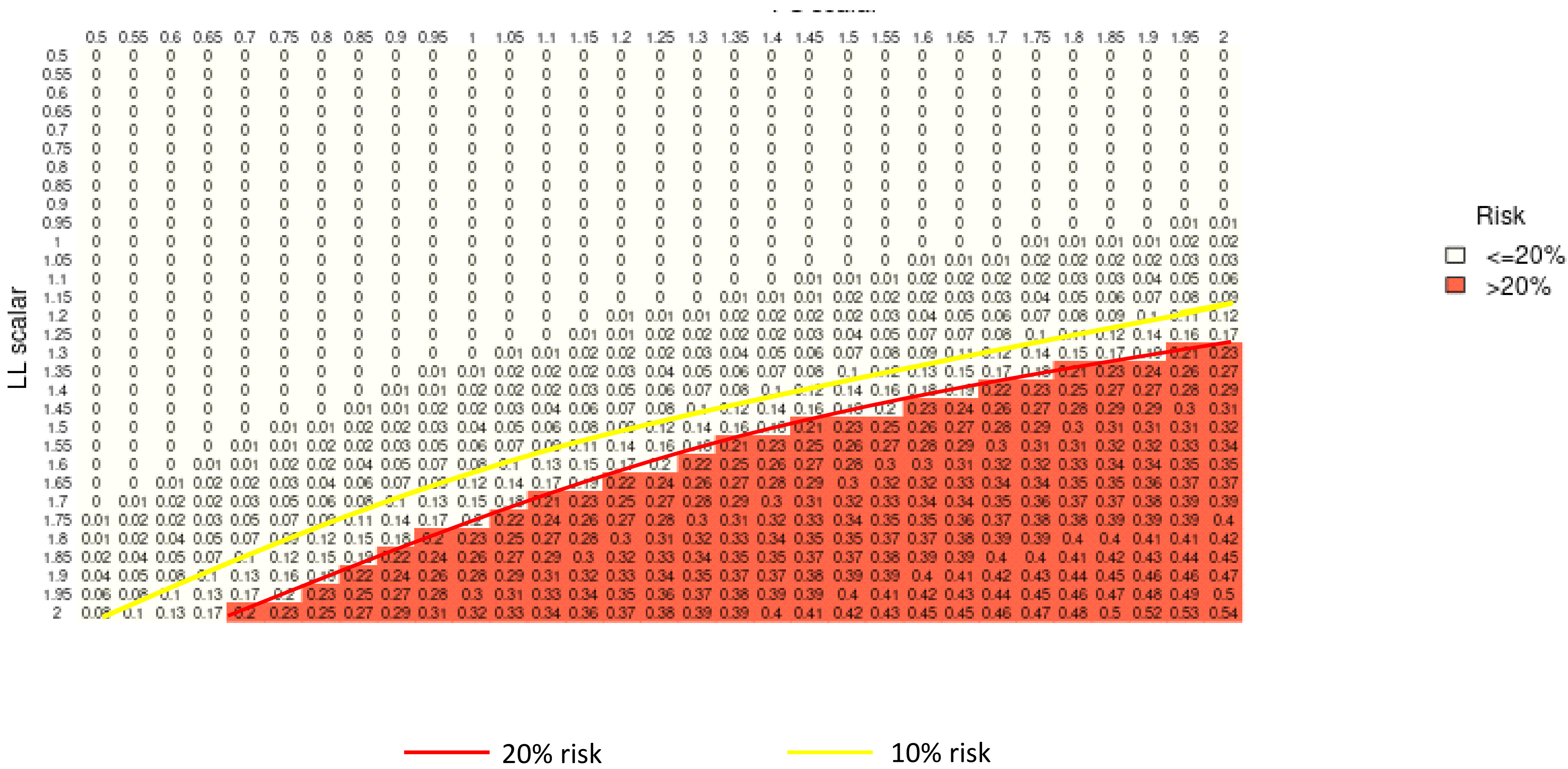


Figure 12. . Risk that the bigeye stock depletion levels ($SB/SB_{F=0}$) resulting under the different purse seine (across) and longline (down) scalars (relative to 2019-21 levels), under the assumption that 'long term' recruitment levels continue, will fall below the limit reference point. Scalar combinations consistent with levels in Table 6 indicated by the different coloured curves.

4 Conditions necessary to achieve a BET TRP at 2012-15 depletion levels, where the FAD closure has been removed

This analysis was a modification of the first depletion level examined in request #3. For this request, removal of the FAD closure defines the multiplier on purse seine FAD sets from the baseline period. As detailed in Table 8, total removal of the FAD closure period represents a FAD set scalar of 1.39 off 2019-2021 conditions (1.47 off 2016-18 average conditions; 1.65 off 2012 levels). To identify the corresponding change in longline bigeye catch necessary to achieve the 2012-2015 bigeye depletion level (34%$SB_{F=0}$), the outputs of request #1 were used. Those conditions, assuming alternative future recruitment scenarios, are presented in Table 7.

Table 7. Catch levels in the longline fishery required to achieve a TRP equivalent to 2012-2015 average depletion levels, where the FAD closure is removed

Future recruitment scenario	PS scalar (2019-2021)	LL scalar (2019-2021)	Approx LL catch (mt)
Recent	1.39	1.45	84,500
Long term	1.39	1.25	72,800

5 Update Tables 9 and 10 of WCPFC18-2021-15: Alternative in-zone and high seas FAD closure durations

To evaluate the impact of changing the FAD closure on purse seine effort, an approach comparable to the analysis of the existing tropical tuna CMM was undertaken (see WCPFC19-2022-13_rev1 for further details).

The latest stock assessments for all three tropical species now have a final assessed year of 2021. We therefore used the same 2019-2021 baseline period for each, which as noted simplifies calculations as constant FAD closure settings have been applied across this period. We adjusted fishing levels relative to those baselines as required for the requested tables (2016-2018 average; 2019 levels).

Where a scenario called for an increase or decrease in the EEZ FAD closure period, FAD sets were adjusted relative to the 9 months in which FAD sets were allowed across the baseline period – i.e. an additional month of in-zone closure subtracted 1/9th of the FAD sets in zone from the baseline value. Where high seas FAD sets were increased or decreased, this was relative to the 7 months where fishing FADs was allowed across the baseline period. In this case, an additional month of high seas closure would reduce the number of sets by 1/7th. Combined, the total number of FAD sets under a scenario was related to the average over the 2019-2021 period to develop the FAD set scalar.

For purse seine effort, any increase in FAD sets were compensated for by decreases in free school sets (and vice versa) to maintain overall effort levels at 2019-2021 levels. Within these settings, the impact of the purse seine fishery component on the three tropical tuna stocks varied.

The changes in amount of FAD sets primarily affect the results for bigeye. For this stock, the change in FAD closure period and variations in overall effort from baseline levels are assumed to be multiplicative – e.g. a decrease in the number of 'days fished' and a decrease in the period within which FAD sets can be made both act to reduce the number of FAD sets. We therefore assume that the general pattern of fishing remains consistent into the future, and the number or proportion of FAD sets made outside a closure is not increased, despite specified changes in FAD closure length (see column 'Overall PS scalar' in Table 8 and Table 9).

Depletion outcomes resulting from the different combinations of FAD closure periods are presented in Table 8 and Table 9 for bigeye under recent and long-term recruitment assumptions, respectively. Longline and other fishery levels were assumed as specified in the table for each scenario (we interpreted the request for a sensitivity analysis of 2019 levels as applying to both purse seine and longline fisheries and applied this variation to ALL requested scenarios, as per WCPFC18-2021-15).

For yellowfin and skipjack, previous analyses (SC10-MI-WP-05; SC11-MI-WP-05) have indicated that with regards to purse seine impacts, it is the overall effort by this gear that is the primary influence on stock status rather than the proportion of FAD sets. Therefore, in these analyses we only account for the impact of overall purse seine effort changes for these stocks (see column 'PS effort and HS PS effort v 2019-21 avg' in Table 8 and Table 9).

Results for each stock are interpreted based upon the relevant scalars estimated, with reference to the tables for bigeye and yellowfin that accompany this paper (see request #1).

We note that in this and other spatial FAD-related analyses presented within this document, we do not specifically apply, for example, the high seas FAD closure only to those regions of the bigeye stock assessment model where the high seas are primarily located. For simplicity, the change is distributed across the tropical regions. However, we note that the impact of changes in high seas FAD closure duration would primarily be felt in the eastern region of the tropics where bigeye catch-per-set is generally above the average for the tropical region. To an extent, the impact of the high seas FAD closure on the bigeye stock will be under-estimated within this analysis as a result.

Table 8. Combinations of specified EEZ and high seas FAD closure periods, purse seine effort and longline catch scenarios, and resulting depletion levels and risk of breaching the LRP (20%$SB_{F=0}$) for bigeye (recent recruitment assumption), yellowfin and skipjack tuna.

Scenario combinations					Resulting Scalars					BET outcomes			YFT outcomes			SKJ outcomes		
EEZ PS effort	**EEZ FAD closure**	**HS FAD closure**	**LL catch**	**Other catch**	**PS effort & HS PS effort v 2019-21 avg**	**FAD closure scalar**	**Overall PS scalar**	**LL catch scalar off 2019-21 avg**	**Other catch scalar off 2019-21 avg**	**BET depletion**	**Result v 2012-15 avg**	**LRP risk**	**YFT depletion**	**Result v 2012-15 avg**	**LRP risk**	**SKJ depletion**	**Result v TRP**	**LRP risk**
2016-18 levels	3mth	6mth	2016-18 levels	2016-18 levels	1.06	0.98	1.04	1.04	1	0.44	1.29	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	4mth	5mth	2016-18 levels	2016-18 levels	1.06	0.90	0.96	1.04	1	0.45	1.32	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	4mth	6mth	2016-18 levels	2016-18 levels	1.06	0.89	0.94	1.04	1	0.46	1.35	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	3mth	5mth	2016-18 levels	2016-18 levels	1.06	1.00	1.06	1.04	1	0.44	1.29	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	2mth	4mth	2016-18 levels	2016-18 levels	1.06	1.12	1.18	1.04	1	0.43	1.26	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	0mth	0mth	2016-18 levels	2016-18 levels	1.06	1.39	1.47	1.04	1	0.4	1.18	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	2mth	3mth	2016-18 levels	2016-18 levels	1.06	1.14	1.20	1.04	1	0.43	1.26	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	2mth	2mth	2016-18 levels	2016-18 levels	1.06	1.16	1.22	1.04	1	0.42	1.24	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	1mth	1mth	2016-18 levels	2016-18 levels	1.06	1.27	1.35	1.04	1	0.41	1.21	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	5mth	5mth	2016-18 levels	2016-18 levels	1.06	0.81	0.86	1.04	1	0.47	1.38	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	4mth	4mth	2016-18 levels	2016-18 levels	1.06	0.92	0.98	1.04	1	0.46	1.35	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	3mth	3mth	2016-18 levels	2016-18 levels	1.06	1.04	1.10	1.04	1	0.44	1.29	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	3mth	2mth	2016-18 levels	2016-18 levels	1.06	1.06	1.12	1.04	1	0.43	1.26	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	4mth	3mth	2016-18 levels	2016-18 levels	1.06	0.94	1.00	1.04	1	0.45	1.32	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	5mth	3mth	2016-18 levels	2016-18 levels	1.06	0.85	0.90	1.04	1	0.47	1.38	0%	0.32	0.73	5%	0.52	1.04	0%
2019 levels	3mth	6mth	2019 levels	2016-18 levels	0.98	0.98	0.97	1.14	1	0.44	1.29	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	4mth	5mth	2019 levels	2016-18 levels	0.98	0.90	0.89	1.14	1	0.45	1.32	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	4mth	6mth	2019 levels	2016-18 levels	0.98	0.89	0.87	1.14	1	0.46	1.35	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	3mth	5mth	2019 levels	2016-18 levels	0.98	1.00	0.99	1.14	1	0.44	1.29	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	2mth	4mth	2019 levels	2016-18 levels	0.98	1.12	1.10	1.14	1	0.42	1.24	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	0mth	0mth	2019 levels	2016-18 levels	0.98	1.39	1.36	1.14	1	0.39	1.15	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	2mth	3mth	2019 levels	2016-18 levels	0.98	1.14	1.12	1.14	1	0.42	1.24	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	2mth	2mth	2019 levels	2016-18 levels	0.98	1.16	1.14	1.14	1	0.42	1.24	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	1mth	1mth	2019 levels	2016-18 levels	0.98	1.27	1.25	1.14	1	0.41	1.21	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	5mth	5mth	2019 levels	2016-18 levels	0.98	0.81	0.80	1.14	1	0.47	1.38	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	4mth	4mth	2019 levels	2016-18 levels	0.98	0.92	0.91	1.14	1	0.45	1.32	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	3mth	3mth	2019 levels	2016-18 levels	0.98	1.04	1.02	1.14	1	0.43	1.26	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	3mth	2mth	2019 levels	2016-18 levels	0.98	1.06	1.04	1.14	1	0.43	1.26	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	4mth	3mth	2019 levels	2016-18 levels	0.98	0.94	0.93	1.14	1	0.44	1.29	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	5mth	3mth	2019 levels	2016-18 levels	0.98	0.85	0.83	1.14	1	0.46	1.35	0%	0.32	0.73	4%	0.54	1.08	0%
2012 levels	3mth	6mth	2019 levels	2016-18 levels	1.19	0.98	1.17	1.14	1	0.41	1.21	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	4mth	5mth	2019 levels	2016-18 levels	1.19	0.90	1.08	1.14	1	0.42	1.24	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	4mth	6mth	2019 levels	2016-18 levels	1.19	0.89	1.05	1.14	1	0.43	1.26	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	3mth	5mth	2019 levels	2016-18 levels	1.19	1.00	1.19	1.14	1	0.41	1.21	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	2mth	4mth	2019 levels	2016-18 levels	1.19	1.12	1.33	1.14	1	0.4	1.18	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	0mth	0mth	2019 levels	2016-18 levels	1.19	1.39	1.65	1.14	1	0.37	1.09	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	2mth	3mth	2019 levels	2016-18 levels	1.19	1.14	1.35	1.14	1	0.39	1.15	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	2mth	2mth	2019 levels	2016-18 levels	1.19	1.16	1.37	1.14	1	0.39	1.15	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	1mth	1mth	2019 levels	2016-18 levels	1.19	1.27	1.51	1.14	1	0.38	1.12	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	5mth	5mth	2019 levels	2016-18 levels	1.19	0.81	0.96	1.14	1	0.44	1.29	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	4mth	4mth	2019 levels	2016-18 levels	1.19	0.92	1.10	1.14	1	0.42	1.24	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	3mth	3mth	2019 levels	2016-18 levels	1.19	1.04	1.24	1.14	1	0.41	1.21	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	3mth	2mth	2019 levels	2016-18 levels	1.19	1.06	1.26	1.14	1	0.41	1.21	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	4mth	3mth	2019 levels	2016-18 levels	1.19	0.94	1.12	1.14	1	0.42	1.24	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	5mth	3mth	2019 levels	2016-18 levels	1.19	0.85	1.01	1.14	1	0.44	1.29	0%	0.29	0.66	12%	0.5	1	0%

Table 9. Combinations of specified EEZ and high seas FAD closure periods, purse seine effort and longline catch scenarios, and resulting depletion levels and risk of breaching the LRP (20%$SB_{F=0}$) for bigeye (long term recruitment assumption), yellowfin and skipjack tuna.

Scenario combinations					Resulting Scalars					BET outcomes			YFT outcomes			SKJ outcomes		
EEZ PS effort	EEZ FAD closure	HS FAD closure	LL catch	Other catch	PS effort & HS PS effort v 2019-21 avg	FAD closure	Overall PS scalar	LL catch scalar	Other catch scalar	BET depletion	Result v 2012-15 avg	LRP risk	YFT depletion	Result v 2012-15 avg	LRP risk	SKJ depletion	Result v TRP	LRP risk
2016-18 levels	3mth	6mth	2016-18 levels	2016-18 levels	1.06	0.98	1.04	1.04	1	0.42	1.24	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	4mth	5mth	2016-18 levels	2016-18 levels	1.06	0.90	0.96	1.04	1	0.43	1.26	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	4mth	6mth	2016-18 levels	2016-18 levels	1.06	0.89	0.94	1.04	1	0.43	1.26	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	3mth	5mth	2016-18 levels	2016-18 levels	1.06	1.00	1.06	1.04	1	0.41	1.21	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	2mth	4mth	2016-18 levels	2016-18 levels	1.06	1.12	1.18	1.04	1	0.4	1.18	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	0mth	0mth	2016-18 levels	2016-18 levels	1.06	1.39	1.47	1.04	1	0.37	1.09	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	2mth	3mth	2016-18 levels	2016-18 levels	1.06	1.14	1.20	1.04	1	0.4	1.18	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	2mth	2mth	2016-18 levels	2016-18 levels	1.06	1.16	1.22	1.04	1	0.39	1.15	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	1mth	1mth	2016-18 levels	2016-18 levels	1.06	1.27	1.35	1.04	1	0.38	1.12	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	5mth	5mth	2016-18 levels	2016-18 levels	1.06	0.81	0.86	1.04	1	0.44	1.29	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	4mth	4mth	2016-18 levels	2016-18 levels	1.06	0.92	0.98	1.04	1	0.42	1.24	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	3mth	3mth	2016-18 levels	2016-18 levels	1.06	1.04	1.10	1.04	1	0.41	1.21	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	3mth	2mth	2016-18 levels	2016-18 levels	1.06	1.06	1.12	1.04	1	0.41	1.21	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	4mth	3mth	2016-18 levels	2016-18 levels	1.06	0.94	1.00	1.04	1	0.42	1.24	0%	0.32	0.73	5%	0.52	1.04	0%
2016-18 levels	5mth	3mth	2016-18 levels	2016-18 levels	1.06	0.85	0.90	1.04	1	0.44	1.29	0%	0.32	0.73	5%	0.52	1.04	0%
2019 levels	3mth	6mth	2019 levels	2016-18 levels	0.98	0.98	0.97	1.14	1	0.41	1.21	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	4mth	5mth	2019 levels	2016-18 levels	0.98	0.90	0.89	1.14	1	0.42	1.24	0%	0.32	0.73	4%	0.54	1.08	0%
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2019 levels	3mth	5mth	2019 levels	2016-18 levels	0.98	1.00	0.99	1.14	1	0.41	1.21	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	2mth	4mth	2019 levels	2016-18 levels	0.98	1.12	1.10	1.14	1	0.39	1.15	0%	0.32	0.73	4%	0.54	1.08	0%
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2019 levels	2mth	3mth	2019 levels	2016-18 levels	0.98	1.14	1.12	1.14	1	0.39	1.15	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	2mth	2mth	2019 levels	2016-18 levels	0.98	1.16	1.14	1.14	1	0.39	1.15	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	1mth	1mth	2019 levels	2016-18 levels	0.98	1.27	1.25	1.14	1	0.37	1.09	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	5mth	5mth	2019 levels	2016-18 levels	0.98	0.81	0.80	1.14	1	0.43	1.26	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	4mth	4mth	2019 levels	2016-18 levels	0.98	0.92	0.91	1.14	1	0.42	1.24	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	3mth	3mth	2019 levels	2016-18 levels	0.98	1.04	1.02	1.14	1	0.4	1.18	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	3mth	2mth	2019 levels	2016-18 levels	0.98	1.06	1.04	1.14	1	0.4	1.18	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	4mth	3mth	2019 levels	2016-18 levels	0.98	0.94	0.93	1.14	1	0.42	1.24	0%	0.32	0.73	4%	0.54	1.08	0%
2019 levels	5mth	3mth	2019 levels	2016-18 levels	0.98	0.85	0.83	1.14	1	0.43	1.26	0%	0.32	0.73	4%	0.54	1.08	0%
2012 levels	3mth	6mth	2019 levels	2016-18 levels	1.19	0.98	1.17	1.14	1	0.38	1.12	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	4mth	5mth	2019 levels	2016-18 levels	1.19	0.90	1.08	1.14	1	0.39	1.15	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	4mth	6mth	2019 levels	2016-18 levels	1.19	0.89	1.05	1.14	1	0.4	1.18	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	3mth	5mth	2019 levels	2016-18 levels	1.19	1.00	1.19	1.14	1	0.38	1.12	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	2mth	4mth	2019 levels	2016-18 levels	1.19	1.12	1.33	1.14	1	0.37	1.09	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	0mth	0mth	2019 levels	2016-18 levels	1.19	1.39	1.65	1.14	1	0.34	1.00	3%	0.29	0.66	12%	0.5	1	0%
2012 levels	2mth	3mth	2019 levels	2016-18 levels	1.19	1.14	1.35	1.14	1	0.36	1.06	1%	0.29	0.66	12%	0.5	1	0%
2012 levels	2mth	2mth	2019 levels	2016-18 levels	1.19	1.16	1.37	1.14	1	0.36	1.06	1%	0.29	0.66	12%	0.5	1	0%
2012 levels	1mth	1mth	2019 levels	2016-18 levels	1.19	1.27	1.51	1.14	1	0.35	1.03	2%	0.29	0.66	12%	0.5	1	0%
2012 levels	5mth	5mth	2019 levels	2016-18 levels	1.19	0.81	0.96	1.14	1	0.41	1.21	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	4mth	4mth	2019 levels	2016-18 levels	1.19	0.92	1.10	1.14	1	0.39	1.15	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	3mth	3mth	2019 levels	2016-18 levels	1.19	1.04	1.24	1.14	1	0.38	1.12	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	3mth	2mth	2019 levels	2016-18 levels	1.19	1.06	1.26	1.14	1	0.37	1.09	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	4mth	3mth	2019 levels	2016-18 levels	1.19	0.94	1.12	1.14	1	0.39	1.15	0%	0.29	0.66	12%	0.5	1	0%
2012 levels	5mth	3mth	2019 levels	2016-18 levels	1.19	0.85	1.01	1.14	1	0.41	1.21	0%	0.29	0.66	12%	0.5	1	0%

PS management

#	Request to SPC
6	Include stock projections for different scenarios of reduced FAD closure (10% 20%, 30% reduction, status quo) in their analyses [to be presented to SC19].
7	Include stock projections for different scenarios of increased FAD closure (10%, 20%, 30% increase) in their analyses.
8	What is the impact to juvenile BET and YFT from decreasing the FAD closure period in terms of $SB/SB_{F=0}$?
9	Examine the implications of the FAD closure on foregone catches of SKJ and YFT
10	Update of Tables 14 and 15 of WCPFC19-2021-15, with the updated TRP from the interim skipjack MP for the reference periods 2012, 2016-2018 and 2018-2021
11	Provide an updated analysis on the potential level of high seas purse seine effort based on the SKJ TRP (SKJ MP output).
12	Table with future purse seine scalars under current conditions, without footnote 1 exemptions, without paragraph 15 exemptions (previous paragraph 17), without HS effort by CCMs in table 2, without HS effort by CCMs not in table 2
13	Provide information to support inclusion of the catch by the Philippines in the high seas limit and how this could be implemented.

6, 7 and 8 Scenarios of increased and reduced FAD closure

The approach used to evaluate alternative FAD closure periods as required by these requests was comparable to that used to address request # 5 above (specifically the FAD closure component). Longline bigeye catch was assumed to remain at 2019-2021 levels (scalar =1). The specific requested percentage changes in FAD closure have been evaluated and applied to both the in-zone and high seas closures equally. For information, results for comparable 'rounded' month or half month closure periods are also presented. Table 10 presents the results under two assumptions for purse seine effort: relative to 2019-2021 levels, and relative to 2012 levels; and under the two assumptions for future bigeye recruitment.

Request #8 included the impact of changes in FAD closure periods on yellowfin tuna. Under the assumption noted under request #5 that overall purse seine effort remains constant in these analyses, and reduced FAD sets due to increased closure duration are therefore transferred to free school sets, there is no impact on the yellowfin tuna stock. Results are therefore not presented here.

Table 10. Implications for long-term bigeye depletion under different percentage increases and decreases in the length of the FAD closure component periods, where purse seine effort is at 2019-2021 average levels, and at 2012 effort levels. Scalars are off the 2019-2021 baseline.

Change in FAD closure period	Resulting (approx.) FAD closure period		PS FAD set scalar relative to 2019-2021 average	Resulting BET $SB/SB_{F=0}$		PS FAD set scalar (off 2019-2021) assuming 2012 effort levels	Resulting BET $SB/SB_{F=0}$	
	EEZ	High Seas		Recent recruitment	Long-term recruitment		Recent recruitment	Long-term recruitment
	4 mths	6.5 mths	0.88	0.47	0.45	1.05	0.45	0.42
30% increase	3.9 mths	6.5 mths	0.88	0.47	0.45	1.05	0.45	0.42
20% increase	3.6 mths	6 mths	0.92	0.47	0.44	1.09	0.45	0.42
	3.5 mths	6 mths	0.93	0.47	0.44	1.11	0.44	0.42
10% increase	3.3 mths	5.5 mths	0.96	0.46	0.44	1.14	0.44	0.41
Status quo	3 mths	5 mths	1.00	046	0.43	1.19	0.43	0.40
10% decrease	2.7 mths	4.5 mths	1.04	0.45	0.42	1.24	0.43	0.40
	2.5 mths	4.5 mths	1.06	0.45	0.42	1.26	0.43	0.40
20% decrease	2.4 mths	4 mths	1.08	0.45	0.42	1.28	0.42	0.40
30% decrease	2.1 mths	3.5 mths	1.12	0.44	0.41	1.33	0.42	0.39
	2 mths	3.5 mths	1.13	0.44	0.41	1.34	0.42	0.39

9. Implications of FAD closure on foregone catch

To estimate the catch that would have been present in the absence of a FAD closure is challenging given that over the past 13 years, FAD closures have influenced fishing behaviour, while catch rates will also be affected by regional oceanographic patterns, etc. We therefore took a pragmatic approach to estimate the level of catch for all three tropical tuna species that might have been taken if a FAD closure period had not been in place:

1. Calculate the average stock specific CPUE (mt/set) for associated and unassociated sets within the month just prior to and following the closure period in a given year;
2. Calculate the average proportion of associated and unassociated sets within the month just prior to and following the closure period in a given year;
3. Apply the proportion of associated and unassociated sets calculated in #2 to the total sets that did occur within each month of the closure period;
4. Multiply those set numbers by the CPUE calculated in #1 to estimate the catch that would have been present in each month.

This analysis therefore assumes that overall, the FAD closure period did not affect:

- the level of fishing effort within FAD closure months - noting that some evidence of a reduction in effort has been seen related to particular closures;
- vessel fishing patterns just prior to and post the closure periods;
- underlying stock status that would influence catch levels over time – noting that the approach takes into account gains due to the FAD closure impact, but not any negative stock impacts if the FAD closure were not in place.

Data analysed were from 'S-BEST' aggregate raised purse seine data within the WCPFC Convention Area between 10°N and 10°S, and excluded data from Indonesian, Vietnamese and Philippines fleets.

The results are presented graphically in Figure 13, and tabulated in Table 11.

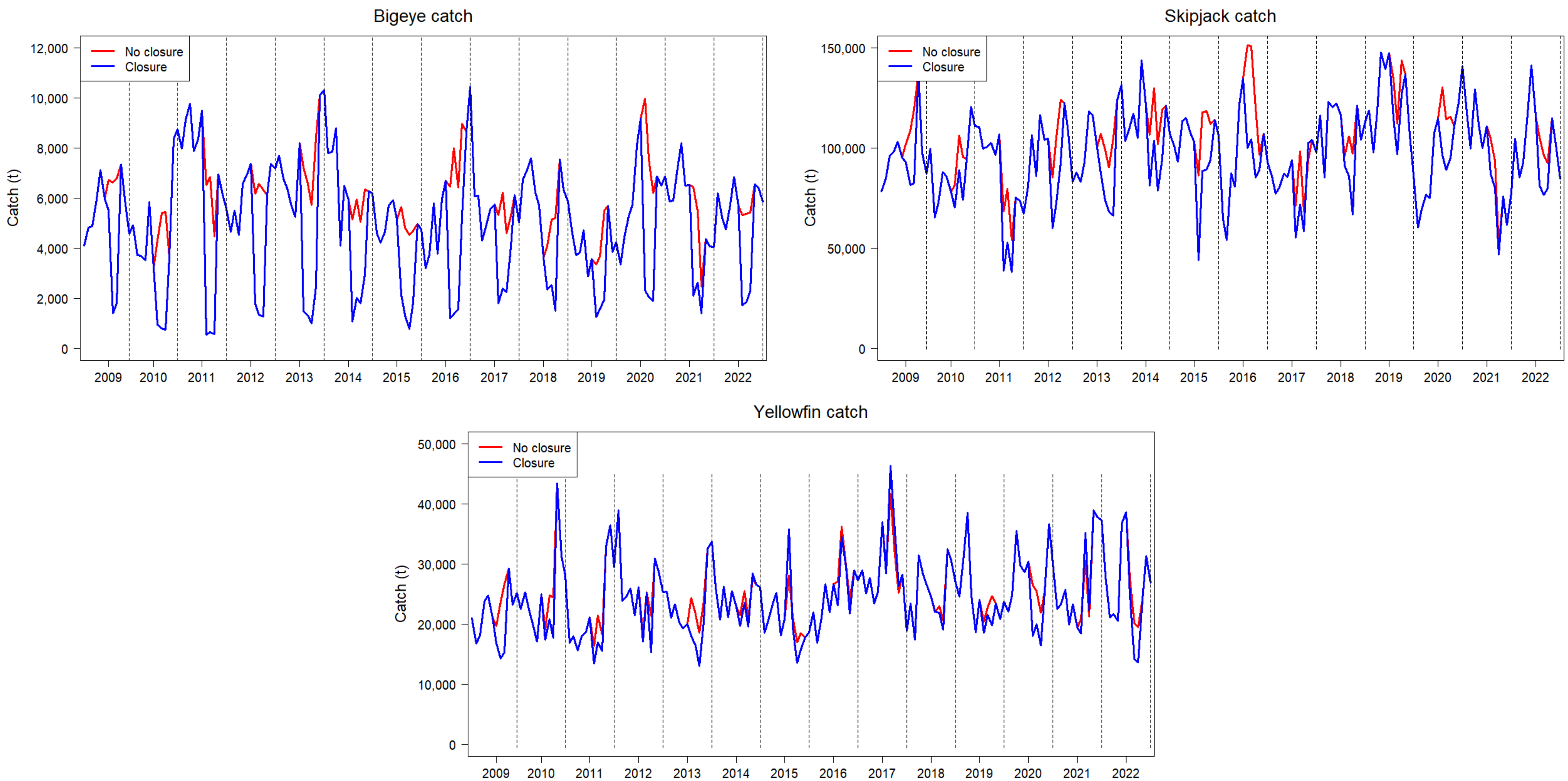

Figure 13. Actual (blue) and estimated (red) monthly tropical purse seine catch of bigeye (top left), skipjack (top right) and yellowfin (bottom) inside the annual FAD closure period from 2009 to 2022. Dotted vertical lines denote calendar years.

Table 11. Total annual additional catch by stock that might have been taken in the absence of the FAD closure periods, and percentage of the 20N20S total purse seine catch.

	Estimated catch (mt) in absence of FAD closure							
	Bigeye		**Skipjack**		**Yellowfin**		**Total**	
YEAR	**MT**	*% of total*	**MT**	*% of total*	**MT**	*% of total*	**MT**	*% of total*
2009	11,442	*16%*	73,519	*5%*	23,546	*7%*	108,507	*6%*
2010	12,673	*22%*	50,097	*4%*	12,473	*4%*	75,243	*5%*
2011	16,087	*20%*	72,507	*6%*	10,159	*3%*	98,753	*7%*
2012	14,685	*21%*	89,855	*7%*	7,283	*2%*	111,823	*6%*
2013	21,651	*28%*	105,548	*7%*	20,555	*6%*	147,754	*8%*
2014	14,701	*21%*	99,179	*6%*	4,303	*1%*	118,184	*6%*
2015	13,606	*25%*	118,373	*9%*	281	*0%*	132,261	*8%*
2016	20,425	*31%*	140,032	*11%*	8,179	*2%*	168,636	*10%*
2017	10,928	*19%*	44,132	*4%*	-9,513	*-2%*	45,548	*3%*
2018	8,094	*12%*	55,036	*4%*	2,520	*1%*	65,651	*4%*
2019	7,736	*16%*	51,316	*3%*	8,112	*2%*	67,164	*3%*
2020	17,528	*27%*	79,903	*6%*	19,375	*5%*	116,806	*6%*
2021	8,314	*14%*	34,252	*3%*	-3,313	*-1%*	39,253	*2%*
2022	10,264	*17%*	56,197	*4%*	14,563	*4%*	81,024	*5%*
Monthly Average	3,995		22,455		2,680		29,131	

10 Update of Tables 14 and 15 of WCPFC19-2021-15, with the updated TRP from the interim skipjack MP for the reference periods 2012, 2016-2018 and 2018-2021

The analysis assumed that changes on the high seas occurred relative to the patterns of fishing over the period 2019 to 2021, thereby simplifying the analysis based upon the consistent FAD closure settings across this period. Within those patterns, the effort in EEZs was assumed to remain at 2012 levels, consistent with the outcomes of the skipjack MP, 2016-2018 average levels, and 2018-2021 average levels as requested, while effort on the high seas changed as specified in the TTMW3 request. Changes in high seas effort were not therefore assumed to lead to increased or decreased fishing within EEZs.

To calculate the number of FAD sets that resulted, the specified number of days available on the high seas in each year were proportioned to each flag operating in the recent 2019-2021 period, relative to the pattern of effort between flags seen in each year (e.g. SC19-MI-IP-06, Table 2), and the average flag-level FAD sets per day (averaged over 2019 and 2021) were applied to those days to get the overall change in FAD sets (EEZ + high seas) relative to the requested baselines. Given the aim of the analysis is to evaluate the potential impact on the bigeye stock (in particular), this approach was taken for all flags and ignores allocation issues or exemptions.

The scalar for purse seine reflected the estimated change in the number of FAD sets relative to the 2019-2021 average level. Longline was assumed to maintain 2019-2021 average catch levels (scalar = 1), while other fisheries were assumed to maintain 2016-2018 average catch levels (consistent with the skipjack MP outputs). Impacts are therefore due to changes in the purse seine fishery only.

Changes in effort on the high seas may also lead to impacts for skipjack tuna. To simplify that analysis, we assumed that the relative pattern of (FAD and free school) sets per day would remain constant at the average over 2019-2021. Hence the scalar influencing skipjack status could be calculated using the change in the annual number of fishing days relative to that seen over the 2019-2021 period, where again the number of days fished within EEZs remained constant, and those on the high seas changed as specified by the TTMW3 request. Pole and line and small-scale fisheries effort/catch were assumed to be at 'baseline' levels as defined by the skipjack harvest strategy. Overall effort scalars are provided relative to other baseline effort levels in the tables, for information.

Table 12. Implications of alternative levels of high seas purse seine effort on overall purse seine fishing levels and consequences for bigeye tuna (under the two hypotheses of future recruitment) and skipjack tuna depletion level, with 2012 EEZ effort levels.

HS effort (days)	PS FAD set scalar relative to 2019-2021 average	Resulting BET $SB/SB_{F=0}$		PS (days) scalar relative to			Resulting SKJ $SB/SB_{F=0}$
		Recent recruitment	Long-term recruitment	2019-2021 average	2016-2018 average	2012	
0	1.14	0.44	0.41	1.14	1.07	0.96	0.51
2,000	1.18	0.43	0.40	1.18	1.11	0.99	0.50
4,000	1.22	0.43	0.40	1.22	1.15	1.03	0.49
6,000	1.26	0.43	0.40	1.27	1.20	1.06	0.49
8,000	1.30	0.42	0.39	1.31	1.24	1.10	0.48
10,000	1.34	0.42	0.39	1.35	1.28	1.14	0.47

Table 13. Implications of alternative levels of high seas purse seine effort on overall purse seine fishing levels and consequences for bigeye tuna (under the two hypotheses of future recruitment) and skipjack tuna depletion levels, with a 2016-18 average baseline EEZ effort level.

HS effort (days)	PS FAD set scalar relative to 2019-2021 average	Resulting BET $SB/SB_{F=0}$		PS (days) scalar relative to			Resulting SKJ $SB/SB_{F=0}$
		Recent recruitment	Long-term recruitment	2019-2021 average	2016-2018 average	2012	
0	0.93	0.47	0.44	0.91	0.86	0.76	0.55
2,000	0.96	0.47	0.44	0.95	0.90	0.80	0.54
4,000	1.00	0.46	0.43	0.99	0.94	0.84	0.53
6,000	1.04	0.45	0.42	1.04	0.98	0.87	0.53
8,000	1.08	0.45	0.42	1.08	1.02	0.91	0.52
10,000	1.12	0.45	0.41	1.12	1.06	0.95	0.51

Table 14. Implications of alternative levels of high seas purse seine effort on overall purse seine fishing levels and consequences for bigeye tuna (under the two hypotheses of future recruitment) and skipjack tuna depletion levels, with a 2018-21 average baseline EEZ effort level.

HS effort (days)	PS FAD set scalar relative to 2019-2021 average	Resulting BET $SB/SB_{F=0}$		PS (days) scalar relative to			Resulting SKJ $SB/SB_{F=0}$
		Recent recruitment	Long-term recruitment	2019-2021 average	2016-2018 average	2012	
0	0.86	0.48	0.45	0.85	0.80	0.71	0.57
2,000	0.90	0.47	0.44	0.89	0.84	0.75	0.56
4,000	0.94	0.47	0.44	0.93	0.88	0.78	0.55
6,000	0.98	0.46	0.43	0.98	0.92	0.82	0.54
8,000	1.02	0.46	0.43	1.02	0.96	0.86	0.53
10,000	1.06	0.45	0.42	1.06	1.00	0.89	0.52

11 Updated analysis on the potential level of high seas purse seine effort based upon SKJ MP outputs

The skipjack management procedure was run and presented to SC19 (SC19-MI-WP-01). The output was a scalar of '1', indicating that the level of fishing in the next 3 year period should be at baseline levels – specifically 2012 effort levels for the purse seine fishery, 2001-04 effort levels for the pole and line fishery, and 2016-2018 levels for the 'other fisheries'. This combination of fishing has been shown to achieve the skipjack TRP on average. The MP therefore indicates the overall effort in the purse seine fishery - 2012 levels. How that level is allocated between (for example) EEZs and high seas is for discussion.

As evaluated in response to request #10, if purse seine effort within EEZs remains at 2012 levels, levels of high seas fishing lie between 2,000 and 4,000 days (see Table 12). In effect, if the pattern of fishing between areas remained the same as in 2012, Table 1 of SC19-MI-IP-06 can therefore be used to indicate the level of high seas effort (days) – i.e. **2,451** days would be available for high seas fishing.

As demonstrated in the calculations presented in the response to request #10, this calculation is highly dependent on the levels of actual fishing in different spatial components of the purse seine fishery, and for the other gears where baseline settings are assumed.

12 Tables with future purse seine FAD set scalars under current conditions (2019-2021) considering removal of exemptions (Footnote 1 and para 15) and high seas effort

For these evaluations, the 'optimistic' scenario is the average effort applied during the period of 2019-21. This is essentially an assumption that status quo fishing continues. The analyses simply show the reduction in FAD set numbers and resulting proportions of the FAD sets conducted during the 2019-2021 period if exemptions (i.e. Footnote 1 and para 15) or high seas effort were removed. Additional information is included showing the approximate reduction in the full FAD closure that could compensate for removing the exemptions or the high seas effort. For completeness tables are also included that show the actual data on FAD sets and tuna catches related to the exemptions.

Footnote 1

This request asked to quantify the effects on the future purse seine FAD set scalar if the Footnote 1 exemption is removed. The Footnote 1 exemption states:

[1] Members of the PNA may implement the FAD set management measures consistent with the Third Arrangement Implementing the Nauru Agreement of May 2008. Members of the PNA shall provide notification to the Commission of the domestic vessels to which the FAD closure will not apply. That notification shall be provided within 15 days of the arrangement being approved. The Secretariat shall provide each year to the Scientific Services Provider and TCC the list of fishing vessels that have not applied the FAD closure in the previous year, as well as their respective numbers of FADs sets during the FADs closure.

For this analysis we have not included FAD sets by the Philippines in HSP1. This is to ensure that the impact of the removal of the Footnote 1 exemption on the FAD sets scalar is not biased by including Philippines HSP1 FAD set that are not equivalent to 'typical' high seas sets on drifting FADs. Typical highs seas FAD sets harvest 5-6 times more tuna that the Philippines HSP1 FAD sets that are on anchored FADs with smaller nets and smaller vessels (see Figure 15 and Figure 16).

Table 15. Summary of the numbers of vessels that notified the Commission of the Footnote 1 exemption, the numbers of vessels that fished under the exemption and their combined numbers of FAD sets and catches of tropical tuna for years 2018-2022.

Year	Vessels		FAD sets	Total catch (MT)			
	Notifying	Fished		Skipjack	Yellowfin	Bigeye	Total
2019	55	55	638	35,484	1,670	394	37,548
2020	92	87	1,116	54,525	6,570	1,553	62,648
2021	92	82	770	21,708	8,915	503	31,126
2022	71	62	775	28,763	1,560	930	31,253

Table 16. Estimated implications for the FAD set scalar based on the 2019-2021 baseline period if the Footnote 1 exemption was removed, and the potential reduction of the full 3 month FAD fishing closure that could compensate for the removal of the Footnote 1 exemption.

Evaluation		Approx. FAD set change	Optimistic scalar	Approximate equivalent main (full) FAD closure period (months)
2019-21 average = 14,746 FAD sets, excludes Phil HSP1)				
1	Footnote 1 (2019)	**-638**	0.96	~ 2.7
2	Footnote 1 (2020)	**-1,116**	0.92	~ 2.5
3	Footnote 1 (2021)	**-770**	0.95	~ 2.6
4	Footnote 1 (2022)	**-775**	0.95	~ 2.6

Paragraph 15

This request asked to quantify the effects on the future purse seine FAD set scalar if the Paragraph 15 exemptions are removed. The Paragraph 15 exemptions state:

*15. In addition to the three-month FAD closure in paragraph 14, **except for those vessels flying the Kiribati flag when fishing in the high seas adjacent to the Kiribati exclusive economic zone**, and **Philippines' vessels operating in HSP1 in accordance with Attachment 2**, it shall be prohibited to deploy, service or set on FADs in the high seas for two additional sequential months of the year. Each CCM shall decide which two sequential months (either April – May or November – December) shall be closed to setting on FADs by their fleets in the high seas for 2022, and 2023 and notify the Secretariat of that decision by March 1, each year. In case a CCM decides to change the notified period at any given year of the application of this CMM this shall be notified to the Secretariat before 1st March of that year.*

For this analysis, as previously mentioned, the difference between FAD sets conducted by the Philippines in HSP1 and vessels fishing in the highs seas adjacent to the Kiribati EEZ is significant and should be taken into account. Previously analyses of these exemptions have combined the Kiribati and Philippines components, but for these analyses we considered it more appropriate to present the analysis for the Kiribati and Philippines HSP1 exemptions separately in the tables below.

Kiribati exemption from additional 2-month high seas FAD closure

Table 17. Summary of the numbers of FAD sets reported from the Kiribati adjacent highs seas during each of the 2-month additional high seas FAD closure period options and the average FAD sets across the two periods each year, along with associated catches estimated for the three tropical tuna species.

Year	Period	FAD sets	Total catch (MT)			
			Skipjack	Yellowfin	Bigeye	Total
2019	Apr-May	178	8,216	139	232	8,587
2019	Nov-Dec	85	2,854	236	213	3,303
2019	**Average**	**132**	**5,535**	**188**	**223**	**5,945**
2020	Apr-May	84	5,566	486	496	6,548
2020	Nov-Dec	50	2,358	170	97	2,625
2020	**Average**	**67**	**3,962**	**328**	**297**	**4,587**
2021	Apr-May	47	1,180	115	55	1,350
2021	Nov-Dec	71	2,113	109	84	2,306
2021	**Average**	**59**	**1,647**	**112**	**70**	**1,828**
2022	Apr-May	12	416	11	13	440
2022	Nov-Dec	91	3,227	59	109	3,395
2022	**Average**	**52**	**1,822**	**35**	**61**	**1,918**

Table 18. Estimated implications for the FAD set scalar based on the 2019-21 baseline period if the Paragraph 15 exemption was removed for the Kiribati adjacent high seas, and the potential reduction of the full 3-month FAD fishing closure that could compensate for the removal of the exemption. For this analysis we do not include FAD sets by Philippines in HSP1.

Evaluation		Approx. FAD set change	Optimistic scalar	Approximate equivalent main (full) FAD closure period (months)
2019-21 average = 14,746 FAD sets, excludes Phil HSP1)				
1	Para 15 Kiribati (2019)	-132	0.99	~ 2.9
2	Para 15 Kiribati (2020)	-67	0.99	~ 2.9
3	Para 15 Kiribati (2021)	-59	0.99	~ 2.9
4	Para 15 Kiribati (2022)	-52	0.99	~ 2.9

Philippines exemption from additional 2-month high seas FAD closure

Table 19. Summary of the numbers of FAD sets reported from the Philippines HSP1 during each of the 2-month additional high seas FAD closure period options and the average FAD sets across the two periods, along with associated catches estimated for the three tropical tuna species. Note the much lower tuna catches relative to the numbers of FAD sets in comparison to Table 17 for the Kiribati adjacent high seas.

Year	Period	FAD sets	Total catch (MT)			
			Skipjack	Yellowfin	Bigeye	Total
2019	Apr-May	661	2,458	1,790	681	4,929
2019	Nov-Dec	501	2,655	1,476	228	4,359
2019	**Average**	**581**	**2,556**	**1,633**	**455**	**4,644**
2020	Apr-May	687	7,058	1,728	291	9,078
2020	Nov-Dec	667	6,534	2,382	94	9,009
2020	**Average**	**677**	**6,796**	**2,055**	**192**	**9,044**
2021	Apr-May	495	3,627	1,473	266	5,366
2021	Nov-Dec	553	2,157	1,431	104	3,693
2021	**Average**	**524**	**2,892**	**1,452**	**185**	**4,530**
2022	Apr-May	468	2,639	852	110	3,602
2022	Nov-Dec	551	4,156	1,386	158	5,700
2022	**Average**	**510**	**3,398**	**1,119**	**134**	**4,651**

Table 20. Estimated implications for the FAD set scalar based on the 2019-21 baseline period if the Paragraph 15 exemption was removed for Philippines HSP1, and the potential reduction of the full 3-month FAD fishing closure that could compensate for the removal of the exemption. Note: For this analysis we present two versions: a) which just indicates the implications of removing the FADs sets for the HSP1 (i.e., Philippines anchored FAD fishery), and, b) which adds the Philippines HSP1 FAD sets to the overall FAD sets analysis but divides the number of Philippines HSP1 FAD sets by 5.6 so the numbers are more equivalent to the high seas FAD sets on drifting FADs in terms of impact.

a) Considering only the Philippines HSP1 anchored FAD fishery

Evaluation		Approx. FAD set change	Optimistic scalar HSP1 FAD sets
2019-21 average = 2446 Philippines HSP1 FAD sets			
1	Para 15 Phil HSP1 (2019)	-581	0.76
2	Para 15 Phil HSP1(2020)	-677	0.72
3	Para 15 Phil HSP1 (2021)	-524	0.79
4	Para 15 Phil HSP1 (2022)	-510	0.79

b) Incorporating the adjusted Philippines HSP1 anchored FAD sets (i.e. divided by 5.6) into the wider high seas purse seine FAD sets for the para 15 exemption evaluation.

Evaluation		Approx. FAD set change (Phil HSP1 adjusted)	Optimistic scalar	Approximate equivalent main (full) FAD closure period (months)
2019-21 average = 15,183 FAD sets, includes Phil HSP1 adjusted sets				
1	Para 15 Phil HSP1 (2019)	-104	0.99	~ 2.9
2	Para 15 Phil HSP1(2020)	-121	0.99	~ 2.9
3	Para 15 Phil HSP1 (2021)	-94	0.99	~ 2.9
4	Para 15 Phil HSP1 (2022)	-91	0.99	~ 2.9

Remove high seas purse seine effort

This request asked to evaluate, a) the effect of removing all reported effort by CCMs with limits in table 2 of CMM 2021-01, and b) the effect of removing all reported effort by CCMs not included in table 2 of CMM 2021-01. Because the Philippines is listed in Table 2 with reference to their HSP1 conditions (Attachment 2 of CMM 2021-01), for this evaluation we included the 'adjusted' FAD set numbers (divide by 5.6) for the Philippines HSP1 FAD set.

Table 21. Estimated implication of removing the high seas effort for CCMs defined in Table 2 of CMM 2021-01 (first four rows) and of CCMs not included in that table (last four rows), by year.

Evaluation		Approx. FAD set change	Optimistic scalar	Approximate equivalent main (full) FAD closure period (months)
CMM evaluation scalars (2019-21 average = 15,183 FAD sets, includes Phil HSP1 adjusted sets)			**1**	3
1	Remove table 2 high seas effort (2019)	-1171	0.92	¬2.5
2	Remove table 2 high seas effort (2020)	-1425	0.91	¬2.3
3	Remove table 2 high seas effort (2021)	-1368	0.91	¬2.4
4	Remove table 2 high seas effort (2022)	-1153	0.92	¬2.5
5	Remove non-table 2 high seas effort (2019)	-1072	0.92	¬2.5
6	Remove non-table 2 high seas effort (2020)	-1187	0.92	¬2.5
7	Remove non-table 2 high seas effort (2021)	-1160	0.92	¬2.5
8	Remove non-table 2 high seas effort (2022)	-551	0.96	¬2.7

13 Information to support inclusion of catch by the Philippines in the high seas limit

Figure 14 to Figure 16 attempt to provide some information on the catch/effort for the Philippines purse seine fleet in the high seas pocket #1 in comparison with the other fleets fishing in the high seas. Table 22 shows the (potentially) adjusted values for the Philippines purse seine fleet high seas days, based on the general observations below (that is, using the scalar of 5.6 to adjust the days).

General Observations

- Figure 14 shows that the monthly CPUE trend for the Philippines purse seine fleet fishing in the HSP#1 has been relatively stable over the past 10+years (based on observer data with high coverage).
- Figure 15 shows that the Monthly CPUE for other purse seine fleets fishing on associated sets in the tropical high seas' areas of the WCPFC is significantly more than the Monthly CPUE for the Philippines fleet in the HSP#1.
- Figure 16 suggests that the Monthly CPUE for the other purse seine fleets fishing on associated sets in the tropical high seas of the WCPFC is on average **5.6 times** that of the Monthly CPUE for the Philippines fleet in the HSP#1 over the period 2012-2022.
- Reasons to possibly explain the difference in CPUE include the smaller, more rudimentary gear on the Philippines purse seine fleet, and that the Philippines purse seine fleet mostly fish on anchored FADs over a small area, while the other fleets mainly fish on drifting FADs over a larger area (and the differences in CPUE between these set types).
- Some statistics on the difference in the gear between the Philippines fleet and other fleets fishing in the high seas obtained from observer data include:
    - The **average net length** on the Philippines purse seine vessel is **438 metres** compared to an average of **1,559 metres** on the other fleets (~3.6 times larger).
    - The **average net depth** on the Philippines purse seine vessel is **133 metres** compared to an average of **263 metres** on the other fleets (~2 times larger).
    - The **average brail size** for the Philippines purse seine fleet is **around 1.8 MT** compared to **around 5.5 MT** on the other fleets (~3 times larger)

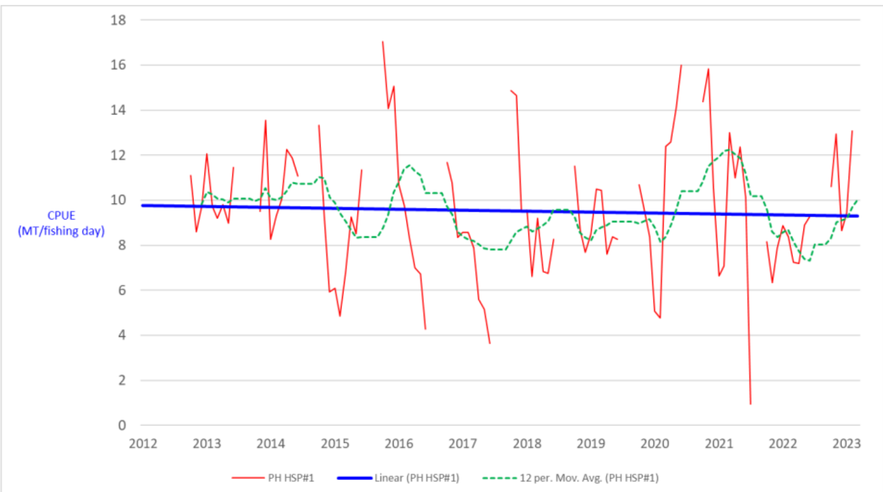

Figure 14. Monthly nominal tuna CPUE (MT/fishing day) for the Philippines purse seine fleet fishing in the HSP#1, 2012-2022. Source of data: Observer data; ASSOCIATED set type only (represent 98% of all sets)

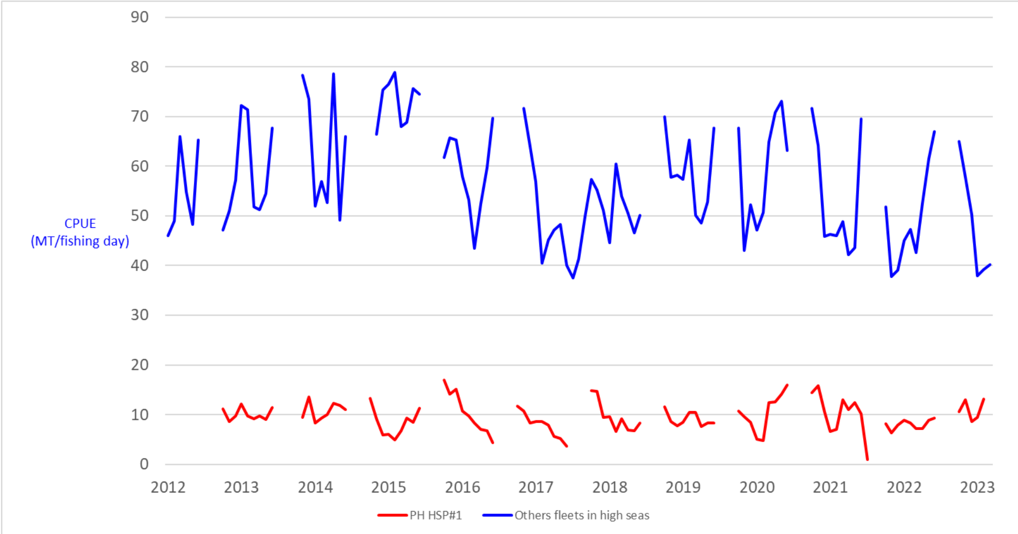

Figure 15. Monthly nominal tuna CPUE (MT/fishing day) for associated sets (2012-2022)

(i) the Philippines purse seine fleet fishing in the HSP#1 (red);
(ii) other fleets fishing in tropical high seas areas of the WCPFC, 2012-2022 (blue).
Source of data : Logsheet data (other fleets); Observer data (PH fleet)

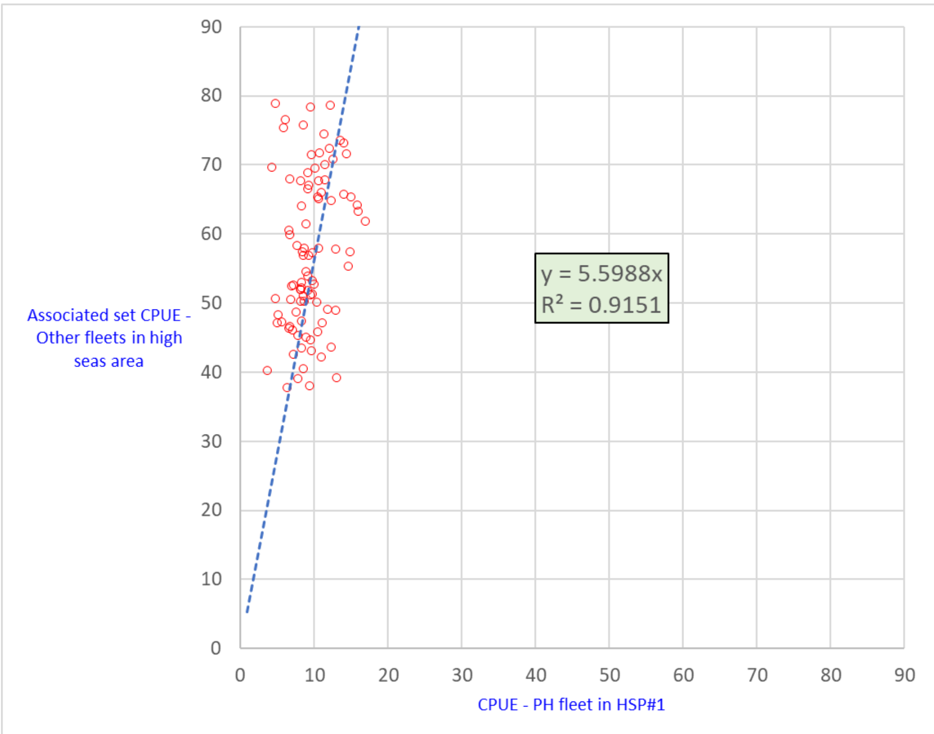

Figure 16. Relationship between monthly nominal tuna CPUE (MT/fishing day) for
(i) the Philippines purse seine fleet fishing in the HSP#1 (**X-Axis**);
(ii) other fleets fishing in tropical high seas areas of the WCPFC, 2012-2022 (**Y-Axis**).
Source of data: Logsheet data (other fleets); Observer data (PH fleet)

Table 22. Purse seine days fished in international waters in the WCPFC-CA between 20°N and 20°S, by flag, based on available operational data, with the adjustment for Philippines high seas days to standardise their level of effort to purse seine effort (days) for other fleets.

PURSE SEINE DAYS FISHED INTERNATIONAL WATERS 20°N-20°S

Flag	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	CMM limits for 2020	CMM limits for 2021	Max. Annual days for 2010-2012	See Notes
CHINA	26	14	8	22	23	12	26	22	16	23	21	26	26	26	11
COOK ISLANDS	0	0	0	0	0	0	0	72	29	185	308				
ECUADOR	13	1	1	0	0	0	0	0	0	0	1	**	**	13	7,9,
EL SALVADOR	32	24	50	54	25	12	28	10	30	27	27	**	**	46	7,9
EUROPEAN UNION	429	371	377	248	87	174	158	146	194	226	214	403	403	429	7
FSM	11	6	10	469	379	600	619	1,053	694	942	404				
INDONESIA	0	0	0	0	0	0	0	0	0	0	0	(0)	(0)		
JAPAN	1	14	8	102	22	0	6	29	21	76	53	121	121	6	
KIRIBATI	183	186	858	645	927	687	795	950	654	566	273				11
MARSHALL ISLANDS	1	5	6	845	393	626	302	955	698	394	177				
NAURU	0	0	0	0	0	0	106	182	397	115	125				
NEW ZEALAND	89	10	44	158	155	123	120	136	63	0	0	160	160		10
PAPUA NEW GUINEA	40	16	36	1,090	98	20	11	0	4	2	2				
PHILIPPINES (adjusted)	*37*	*731*	*476*	*435*	*472*	*481*	*491*	*474*	*471*	*453*	*458*	*832*	*832*		4,5
REPUBLIC OF KOREA	19	23	192	169	197	184	198	182	172	102	50	207	207	205	
SOLOMON ISLANDS	1	0	0	0	25	73	102	91	19	1	0				
TUVALU	1	0	1	85	147	103	57	71	127	209	61				
CHINESE TAIPEI	20	75	44	93	95	108	62	84	62	57	59	95	95	83	7,12
USA	1,237	1,016	1,152	1,665	917	831	1,551	1,485	1,658	721	700	1,270	1,270	1,237	7, 13
VANUATU	6	7	2	0	163	190	107	145	132	133	121				
TOTAL	2,146	2,499	3,265	6,080	4,125	4,224	4,739	6,087	5,441	4,232	3,054				

PHILIPPINES PURSE SEINE -- Unadjusted DAYS FISHED INTERNATIONAL WATERS 20°N-20°S

Flag	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	CMM limits for 2020	CMM limits for 2021	Max. Annual days for 2010-2012	See Notes
PHILIPPINES	*209*	*4,096*	*2,665*	2,437	2,642	2,696	2,749	2,654	2,635	2,539	2,562	4,659	4,659		4,5

LL management

#	Request to SPC
14	Analysis of catch, effort, and catch-per-unit-effort (in weight per day) by zone and high seas, for longline fisheries and fleets

To address this request, a range of longline catch, effort, and catch-per-unit-effort (in weight per day) summaries are provided by area and fleet. Overall geographical distributions of longline effort and CPUE are provided for bigeye (Figure 18) and yellowfin (Figure 19). Estimated annual catch and CPUE of bigeye and yellowfin by flag within grouped EEZs and high seas are provided in Table 23 to Table 26. Trends in annual estimated CPUE (mt/day) by fleet in these areas for the core tropical fishery are provided in Figure 20 and Figure 21, and divided east and west of 170°E in Figure 22 to Figure 25.

Additional notes for the reader are:

1. Annual catch estimates for EEZs and high seas areas (ACE by EEZ-HS) are determined by disaggregating the Annual catch estimates for the WCPFC Area according to annual catch by gear, fleet and species in the available operational catch and effort (logbook) data.
2. There is some uncertainty in ACE by EEZ-HS for some fleets prior to 2017 due to incomplete (low) and spatially biased coverage of available logsheet data for some fleets, particularly for distant-water fleets.
3. Annual catch estimates for the entire EEZ for the following countries have been included, even though some of their EEZ falls outside the core WCPFC tropical longline fishery (20°N–10°S) : Cook Islands, Solomon Islands, USA-Hawaii.
4. Estimates for the Indonesia EEZ are excluded due to the lack of longline EFFORT and CPUE data.
5. The EEZ of French Polynesia has been excluded given the relatively small proportion of their total EEZ lying north of 10°N.
6. Estimates of DAYS effort have been obtained by determining the BET+YFT CPUE (MT/day) from available operational data and applying this to ACE (for BET+YFT) by EEZ-HS by gear, fleet and broad area (EEZs and HS). The caveat listed under 2. above is relevant to this calculation.
7. Fleets with BET+YFT estimated catches which were consistently <100 MT were excluded.
8. Estimates of effort (DAYS) was not undertaken where available logsheet coverage was < 4%.

Figure 17. Map of the WCPFC Area, highlighting the EEZs and high seas areas in the core WCPFC tropical longline fishery (20°N–10°S)

General observations include:

- Bigeye tuna CPUE is generally higher in the eastern tropical WCPFC area (east of 170°E), and Yellowfin tuna CPUE is generally higher in the western tropical WCPFC area (west of 170°E);
- Bigeye tuna CPUE for EEZs and high seas for domestic fleets generally align, no doubt because they fish in a relatively small contiguous area (i.e. their own EEZ and adjacent high seas areas). For example, see Kiribati, Tuvalu, USA and Samoa in Figure 22). This is also the case for the Chinese Taipei fleet in Figure 22.
- Yellowfin tuna CPUE for EEZs and high seas for domestic fleets also align in some cases for the same reason. For example, see FSM, Marshall Islands and Solomon Islands in Figure 24). This is also the case for the China in Figure 24.
- Instances where CPUE between the EEZs and high seas diverge for a fleet may be related to several factors including restricted access to certain EEZs.

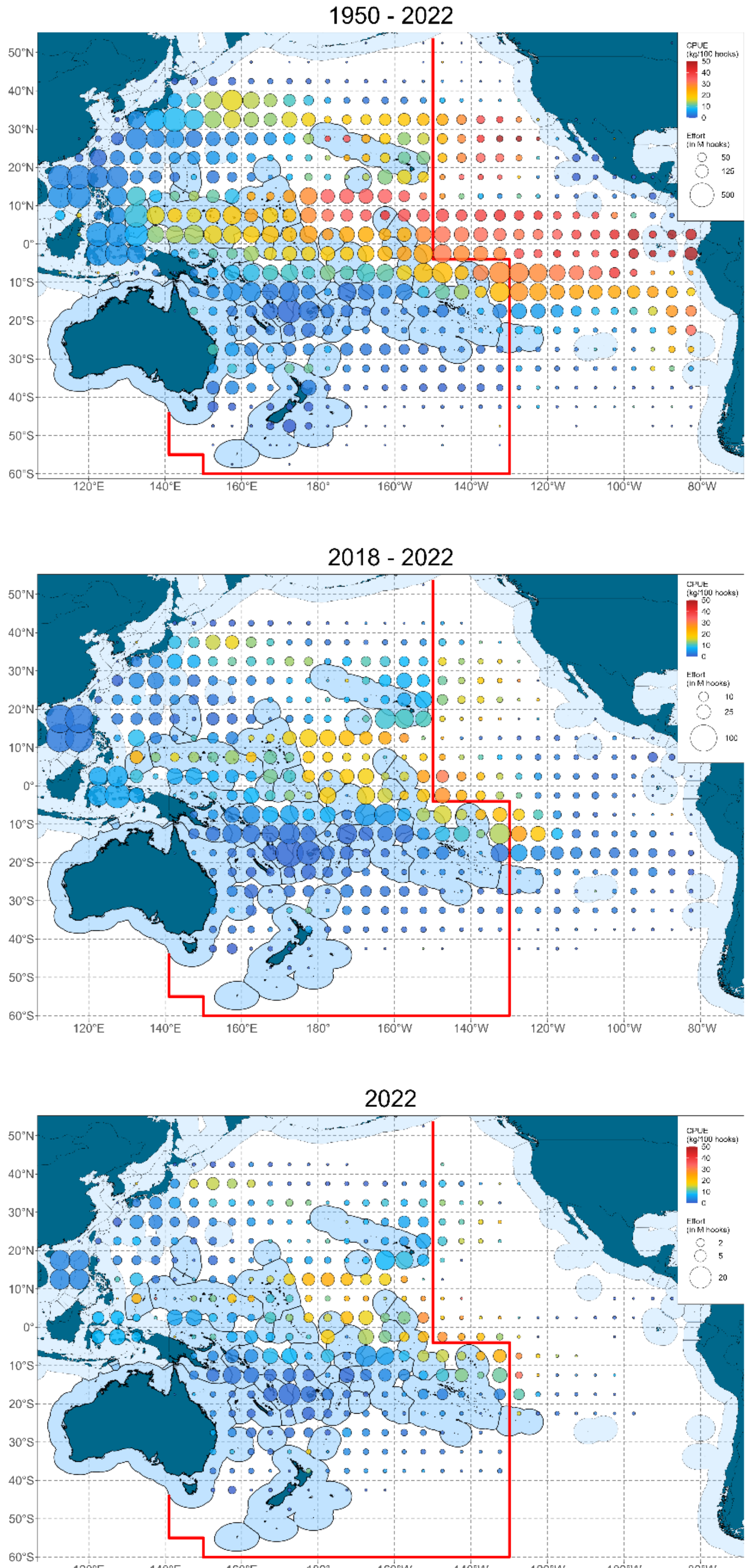

Figure 18. Distribution of 5°x5° longline effort (represented by circle size) and bigeye tuna CPUE (represented by colour) for the period 1950-2022 (top), 2018-2022 (middle) and 2022 (bottom).

Taken from Figure 20 in S19 SA WP-06. Note the differences in scales between plots. The WCPFC-CA is outlined in red. Catch data for the EPO in 2022 are incomplete.

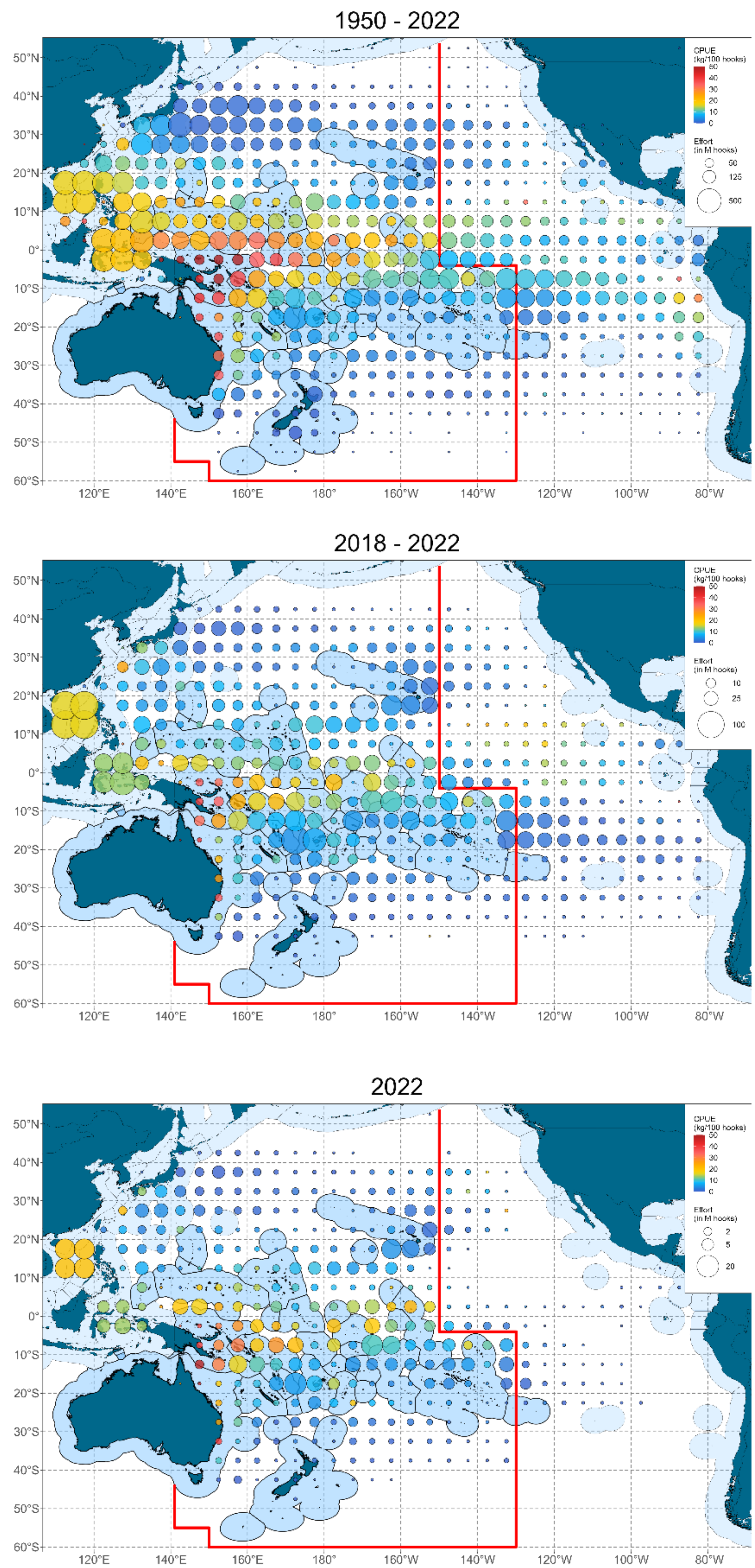

Figure 19. Distribution of 5°x5° longline effort (represented by circle size) and yellowfin tuna CPUE (represented by colour) for the period 1950-2022 (top), 2018-2022 (middle) and 2022 (bottom).

Taken from Figure 28 in S19 SA WP-06. Note the differences in scales between plots. The WCPFC-CA is outlined in red. Catch data for the EPO in 2022 are incomplete.

Table 23. Annual estimated catch (MT) of BIGEYE TUNA in the EEZs (top) and HIGH SEAs (bottom) by fleet for the core WCPFC tropical fishery (20°N–10°S), 2010-2022

flag	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CHINA	4,386	4,979	6,841	5,153	6,486	6,143	3,238	1,588	1,389	1,089	2,093	613	1,362
CHINESE TAIPEI	1,677	3,549	4,135	3,496	4,392	1,868	2,371	1,603	834	139	168	133	375
COOK ISLANDS	300	923	1,603	170	181	151	167	289	170	96	77	74	69
FIJI	123	868	832	390	707	388	532	177	145	394	172	69	73
FSM	1,036	1,344	1,516	1,183	2,301	2,041	1,772	2,086	2,951	2,182	2,118	1,595	1,366
JAPAN	2,592	3,715	3,660	2,373	3,946	2,976	1,748	3,412	3,362	3,045	2,068	1,762	1,095
KIRIBATI	0	89	618	363	231	358	502	233	267	1,225	666	548	2,229
KOREA	3,165	3,144	4,373	2,696	7,245	6,262	4,807	933	1,137	1,569	113	168	234
MARSHALL ISLANDS	213	205	284	77	0	0	696	1,217	1,136	1,449	763	921	1,172
PALAU	0	0	0	0	0	0	0	1,038	931	787	1	0	1
PNG	39	59	109	32	52	13	9	3	87	52	17	0	179
SAMOA	0	0	0	0	0	0	17	60	19	104	91	64	99
SOLOMON ISLANDS	650	172	0	0	2,306	3,454	216	0	1,219	1,273	501	609	863
TUVALU	0	74	991	90	57	180	83	87	55	42	4	20	0
USA	1,205	1,760	1,811	1,759	1,716	3,541	3,483	3,383	3,075	4,427	4,252	3,890	3,522
VANUATU	690	718	1,108	651	2,137	2,437	1,103	164	60	72	46	22	17

flag	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CHINA	9,516	6,062	4,304	5,274	2,701	1,721	4,578	5,122	7,029	7,402	4,976	4,792	4,132
CHINESE TAIPEI	10,130	7,549	6,659	6,858	5,587	7,469	6,987	7,536	7,411	7,974	5,904	6,629	8,475
COOK ISLANDS	8	0	12	32	0	0	16	9	5	15	2	4	4
FIJI	20	210	385	311	590	414	308	158	153	191	54	66	33
FSM	77	156	184	86	187	255	97	48	156	1,377	39	11	9
JAPAN	4,271	3,663	3,722	3,290	3,640	2,607	2,378	1,083	1,146	1,100	768	386	825
KIRIBATI	0	66	182	219	37	198	100	52	114	64	903	72	458
KOREA	10,749	12,132	14,450	10,119	5,534	4,426	6,210	9,287	12,691	12,142	12,895	13,517	12,751
MARSHALL ISLANDS	44	54	51	3	0	0	4	12	10	9	1	7	1
PALAU	0	0	0	0	0	0	0	68	79	68	0	0	0
PNG	0	0	10	0	0	0	2	0	0	0	0	0	0
SAMOA	0	0	0	0	1	0	5	18	1	1	3	0	1
SOLOMON ISLANDS	37	40	0	0	623	671	66	0	16	36	13	16	10
TUVALU	0	31	417	30	19	6	20	23	9	11	2	2	0
USA	1,246	1,302	1,184	1,027	1,360	1,317	1,398	793	571	1,013	1,224	1,101	1,328
VANUATU	1,121	846	604	726	767	3,921	1,927	2,650	2,082	1,566	1,322	1,432	1,448

Table 24. Annual estimated CPUE (MT/day) of BIGEYE TUNA in the EEZs (top) and HIGH SEAs (bottom) by fleet for the core WCPFC tropical fishery (20°N–10°S), 2010-2022

flag	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CHINA	0.3661	0.3628	0.3863	0.2702	0.3552	0.4358	0.2275	0.1650	0.1294	0.1578	0.1331	0.0857	0.0962
CHINESE TAIPEI	0.1113	0.1688	0.2051	0.1892	0.2750	0.2654	0.1918	0.1551	0.1475	0.1875	0.2480	0.2207	0.2567
COOK ISLANDS	0.0757	0.1180	0.1084	0.0756	0.0879	0.0555	0.0871	0.0692	0.0578	0.0398	0.0411	0.0525	0.0538
FIJI	0.0737	0.1451	0.2244	0.1155	0.2048	0.1837	0.1482	0.1341	0.1020	0.1792	0.1447	0.2650	0.1560
FSM	0.2429	0.3255	0.3084	0.2549	0.4243	0.3551	0.2418	0.2898	0.3168	0.2492	0.1908	0.2126	0.2418
JAPAN	0.2203	0.3351	0.3488	0.2788	0.5328	0.4157	0.2857	0.4800	0.4328	0.4125	0.4148	0.3908	0.3219
KIRIBATI	0	0.5162	0.5666	0.3994	0.5044	0.3414	0.2634	0.2433	0.2762	0.3447	0.1724	0.3287	0.4247
KOREA	0.3824	0.4148	0.5077	0.4482	0.6069	0.6517	0.5308	0.4174	0.5492	0.5374	0.4928	0.6574	0.5018
MARSHALL ISLANDS	0.2496	0.3039	0.3160	0.2745	0	0	0.2548	0.1951	0.2930	0.3477	0.2268	0.2909	0.2726
PALAU	0	0	0	0	0	0	0	0.2234	0.1556	0.1572	0.0870	0	0.0399
PNG	0.0213	0.0251	0.0182	0.0163	0.0118	0.0080	0.0099	0.0035	0.0508	0.0986	0.0189	0	0.0836
SAMOA	0	0	0	0	0.0385	0	0.0873	0.0555	0.0583	0.0759	0.0867	0.0903	0.0816
SOLOMON ISLANDS	0.0104	0.1067	0	0	0.0834	0.1211	0.0690	0	0.1356	0.1160	0.0938	0.0951	0.1061
TUVALU	0	0.3089	0.4856	0.1959	0.4085	0.3734	0.2136	0.1960	0.1678	0.2086	0.1500	0.3518	0
USA	0.1436	0.2594	0.2929	0.2949	0.3436	0.3841	0.3379	0.3746	0.2851	0.2676	0.2813	0.2690	0.2317
VANUATU	0.2645	0.1971	0.1615	0.0956	0.3548	0.3414	0.2425	0.1276	0.0895	0.2123	0.0832	0.0799	0.1196

flag	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CHINA	0.5241	0.3727	0.3754	0.2696	0.4279	0.4862	0.2651	0.2418	0.2562	0.2954	0.2646	0.2689	0.2753
CHINESE TAIPEI	0.3745	0.2914	0.2583	0.2049	0.4151	0.4136	0.4822	0.1471	0.1375	0.1325	0.1581	0.1646	0.1905
COOK ISLANDS	0.2148	0.0010	0.4244	0.1664	0.0010	0.0503	0.2799	0.0488	0.3946	0.3182	0.1300	0.0914	0.1495
FIJI	0.1571	0.2032	0.2510	0.1996	0.3234	0.3201	0.3086	0.2844	0.3254	0.2838	0.1813	0.2768	0.1838
FSM	0.2258	0.3438	0.4329	0.2671	0.3820	0.3786	0.2324	0.1734	0.1778	0.2198	0.0948	0.1467	0.1477
JAPAN	0.2159	0.3172	0.4419	0.4184	0.5142	0.2806	0.2894	0.2196	0.2255	0.1957	0.2269	0.0766	0.1789
KIRIBATI	0	0.3874	0.5228	0.5179	0.4139	0.3818	0.3135	0.2997	0.1522	0.2241	0.2934	0.2236	0.3740
KOREA	0.4755	0.5085	0.5040	0.5559	0.6005	0.5993	0.5606	0.6440	0.6776	0.6449	0.6575	0.6748	0.6353
MARSHALL ISLANDS	0.2777	0.3534	0.4542	0.2154	0	0	0.1466	0.1620	0.2911	0.2948	0.2457	0.3426	0.1840
PALAU	0	0	0	0	0	0	0	0.0612	0.0717	0.1055	0.0010	0	0.0010
PNG	0.0010	0.0010	0.4556	0.0010	0.0010	0.0010	0.2507	0.0010	0.0010	0.0010	0.0010	0	0.0010
SAMOA	0	0	0	0	0.0280	0	0.1548	0.1449	0.0884	0.0685	0.0955	0.0010	0.0785
SOLOMON ISLANDS	0.0010	0.3651	0	0	0.1442	0.2284	0.0953	0	0.0586	0.1332	0.2268	0.2206	0.1299
TUVALU	0	0.4013	0.6192	0.3419	0.5160	0.3353	0.4424	0.2034	0.1629	0.2156	0.1320	0.3390	0
USA	0.1847	0.3822	0.3091	0.2958	0.3935	0.4582	0.4430	0.3841	0.3799	0.3630	0.3786	0.3158	0.2914
VANUATU	0.3663	0.4436	0.1971	0.2066	0.4975	0.7477	0.4611	0.5126	0.4816	0.5331	0.5199	0.5875	0.5694

Table 25. Annual estimated catch (MT) of YELLOWFIN TUNA in the EEZs (top) and HIGH SEAs (bottom) by fleet for the core WCPFC tropical fishery (20°N–10°S), 2010-2022

flag	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CHINA	1,482	1,902	2,557	2,771	3,875	3,952	3,125	3,024	2,741	2,099	4,594	2,261	6,448
CHINESE TAIPEI	2,222	4,177	5,606	3,556	2,300	1,287	4,669	6,077	2,534	691	128	157	621
COOK ISLANDS	183	394	686	306	491	339	305	605	486	299	274	277	201
FIJI	360	1,429	1,238	781	763	325	1,627	662	354	934	678	137	187
FSM	484	668	668	798	1,443	1,514	1,678	1,331	2,245	2,750	1,924	1,717	1,900
JAPAN	6,859	3,892	4,192	2,619	1,768	2,690	4,216	4,241	4,268	4,667	1,962	2,529	3,361
KIRIBATI	0	46	265	133	93	159	543	308	134	830	813	771	2,211
KOREA	2,829	2,469	2,756	2,005	5,492	5,436	4,701	1,568	1,101	2,332	258	285	496
MARSHALL ISLANDS	104	86	101	46	0	0	575	944	700	1,168	742	632	963
PALAU	0	0	0	0	0	0	0	1,232	1,727	1,539	0	0	5
PNG	2,147	2,303	2,958	1,041	1,568	891	713	1,205	2,070	1,358	116	0	1,779
SAMOA	0	0	0	0	0	0	27	139	58	245	215	133	244
SOLOMON ISLANDS	4,141	571	0	0	11,121	13,695	1,278	0	4,362	4,963	2,615	3,263	5,444
TUVALU	0	243	417	109	36	161	115	136	90	61	8	8	0
USA	301	539	416	374	194	320	396	775	690	612	504	854	661
VANUATU	437	1,006	1,440	966	1,078	1,484	945	235	269	182	202	99	30

flag	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CHINA	916	2,155	2,560	757	927	1,453	1,583	3,061	5,198	7,101	3,787	6,648	2,136
CHINESE TAIPEI	19,746	16,347	10,746	10,805	9,725	12,395	12,576	14,327	11,378	14,183	7,390	9,636	13,500
COOK ISLANDS	2	0	5	20	0	0	10	5	2	13	1	8	2
FIJI	51	193	378	257	645	550	255	143	81	204	84	72	41
FSM	31	82	82	52	196	177	93	85	150	1,942	83	12	15
JAPAN	5,185	2,687	2,775	2,058	1,832	1,621	1,512	1,436	1,032	1,092	310	546	788
KIRIBATI	0	94	35	42	15	246	57	34	44	31	459	119	276
KOREA	4,814	5,386	5,076	3,702	2,879	3,915	3,352	5,440	5,417	11,515	10,686	10,055	11,019
MARSHALL ISLANDS	13	13	12	1	0	0	3	4	7	7	1	2	1
PALAU	0	0	0	0	0	0	0	118	153	105	0	0	0
PNG	0	0	3	0	0	0	2	0	0	0	0	0	0
SAMOA	0	0	0	0	2	0	6	19	1	2	2	0	1
SOLOMON ISLANDS	102	55	0	0	723	874	349	0	89	107	28	23	24
TUVALU	0	41	36	5	5	4	9	26	16	15	1	0	0
USA	227	350	231	188	256	202	409	438	317	423	417	733	1,002
VANUATU	245	247	451	553	312	1,095	653	448	569	709	363	256	375

Table 26. Annual estimated CPUE (MT/day) of YELLOWFIN TUNA in the EEZs (top) and HIGH SEAs (bottom) by fleet for the core WCPFC tropical fishery (20°N–10°S), 2010-2022

flag	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CHINA	0.1667	0.1400	0.1448	0.1452	0.2493	0.2824	0.2195	0.3137	0.2551	0.3040	0.2922	0.3161	0.4556
CHINESE TAIPEI	0.2521	0.2089	0.2781	0.1927	0.2771	0.3350	0.3784	0.4377	0.3831	0.5818	0.1748	0.2811	0.3228
COOK ISLANDS	0.1231	0.2107	0.1322	0.1294	0.2533	0.1443	0.1629	0.1548	0.1448	0.1041	0.1156	0.1721	0.1353
FIJI	0.3723	0.2651	0.2576	0.1870	0.2840	0.4196	0.4228	0.4622	0.2486	0.4189	0.5589	0.4673	0.3959
FSM	0.1161	0.1479	0.1286	0.1961	0.2865	0.2638	0.2328	0.2106	0.2227	0.3097	0.1943	0.2204	0.3308
JAPAN	0.5877	0.3513	0.3999	0.3082	0.2387	0.3760	0.6892	0.5968	0.5495	0.6321	0.3936	0.5608	0.9880
KIRIBATI	0	0.2688	0.2578	0.1955	0.3216	0.1936	0.2861	0.2400	0.1388	0.2298	0.2103	0.3306	0.4451
KOREA	0.3422	0.3241	0.3192	0.3331	0.4625	0.5728	0.5123	0.6858	0.4834	0.7911	0.8314	0.8504	0.8759
MARSHALL ISLANDS	0.1331	0.1287	0.1186	0.2077	0	0	0.1993	0.1680	0.1625	0.2910	0.2172	0.1984	0.2192
PALAU	0	0	0	0	0	0	0	0.2842	0.3179	0.2947	0.0002	0	0.1871
PNG	0.5612	0.4391	0.4475	0.4232	0.5146	0.6433	0.4435	0.5923	0.8076	0.7502	0.4602	0	0.6466
SAMOA	0	0	0	0	0.0447	0	0.0958	0.1383	0.1815	0.1774	0.1726	0.2649	0.2090
SOLOMON ISLANDS	0.1544	0.1687	0	0	0.3545	0.4888	0.3954	0	0.4719	0.4384	0.4801	0.4995	0.6616
TUVALU	0	0.3791	0.2987	0.2294	0.4561	0.3205	0.2938	0.3131	0.2637	0.3124	0.3187	0.1524	0
USA	0.0559	0.1007	0.0824	0.0616	0.0374	0.0666	0.0883	0.1576	0.1405	0.0778	0.0824	0.0981	0.1035
VANUATU	0.1818	0.2725	0.1976	0.1393	0.2021	0.2063	0.1977	0.1960	0.2636	0.4329	0.2142	0.2701	0.2076

flag	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CHINA	0.1206	0.1361	0.0929	0.0808	0.1837	0.1899	0.1715	0.1891	0.1753	0.3952	0.1889	0.2429	0.1370
CHINESE TAIPEI	0.1283	0.1742	0.1586	0.1096	0.2365	0.1792	0.1737	0.1936	0.1570	0.1954	0.1465	0.2053	0.2475
COOK ISLANDS	0.1813	0.0010	0.4910	0.1009	0.0010	0.0877	0.1824	0.0325	0.1138	0.2309	0.0585	0.1905	0.0571
FIJI	0.3254	0.1945	0.1898	0.1330	0.2451	0.3050	0.2341	0.2371	0.1713	0.2973	0.2784	0.2745	0.2266
FSM	0.0944	0.1659	0.1649	0.1356	0.3411	0.2640	0.2306	0.2060	0.2406	0.3574	0.2253	0.1529	0.2288
JAPAN	0.3634	0.1974	0.1808	0.0758	0.0628	0.1429	0.1317	0.1417	0.1171	0.2033	0.0758	0.0883	0.1190
KIRIBATI	0	0.2163	0.1087	0.1316	0.2669	0.1962	0.1794	0.1251	0.2392	0.1073	0.0833	0.2651	0.2829
KOREA	0.2116	0.1495	0.1314	0.1823	0.2955	0.5366	0.2925	0.3742	0.2894	0.6102	0.5455	0.5037	0.5502
MARSHALL ISLANDS	0.0880	0.0822	0.1153	0.0604	0	0	0.0809	0.0628	0.1873	0.2293	0.2967	0.1208	0.1722
PALAU	0	0	0	0	0	0	0	0.1147	0.1530	0.1562	0.0010	0	0.0010
PNG	0.0010	0.0010	0.1121	0.0010	0.0010	0.0010	0.1253	0.0010	0.0010	0.0010	0.0010	0	0.0010
SAMOA	0	0	0	0	0.1201	0	0.1376	0.1569	0.1373	0.1177	0.0373	0.0010	0.1605
SOLOMON ISLANDS	0.0010	0.1291	0	0	0.1920	0.3942	0.5394	0	0.3139	0.3827	0.4630	0.3098	0.2993
TUVALU	0	0.2013	0.0795	0.0635	0.2202	0.2200	0.1910	0.2382	0.2652	0.2925	0.0879	0.0454	0
USA	0.0336	0.0908	0.0660	0.0647	0.0594	0.0627	0.1145	0.1990	0.1535	0.1140	0.0989	0.1750	0.1546
VANUATU	0.0789	0.1285	0.1386	0.1145	0.1347	0.1996	0.1491	0.0835	0.1091	0.1697	0.1242	0.0992	0.1470

Table 5. Annual estimated effort (DAYS) in the EEZs (top) and HIGH SEAs (bottom) by fleet for the core WCPFC tropical fishery (20°N–10°S), 2010-2022

flag	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CHINA	11,015	13,687	17,696	19,077	17,140	14,056	14,237	9,637	10,743	6,902	15,724	7,150	14,154
CHINESE TAIPEI	10,729	20,455	20,157	18,470	12,121	5,256	12,349	12,957	6,348	1,079	700	578	1,718
COOK ISLANDS	2,430	4,007	9,513	2,323	1,968	2,448	1,886	3,993	3,236	2,749	2,242	1,563	1,430
FIJI	1,083	5,599	4,296	3,872	3,007	1,181	3,782	1,407	1,423	2,219	1,208	281	471
FSM	4,233	4,249	4,998	4,393	5,267	5,743	7,268	6,830	9,632	8,825	10,496	7,648	5,704
JAPAN	11,696	11,080	10,488	8,505	7,407	7,156	6,117	7,107	7,768	7,382	4,985	4,509	3,402
KIRIBATI	0	173	1,070	834	393	965	1,903	1,119	967	3,577	3,864	2,001	5,104
KOREA	8,271	7,596	8,622	6,017	11,909	9,553	9,115	2,267	2,168	2,937	280	300	530
MARSHALL ISLANDS	831	673	885	256	0	0	2,799	5,948	4,032	4,098	3,390	3,174	4,342
PALAU	0	0	0	0	0	0	0	4,473	5,613	5,148	11	0	26
PNG	3,753	5,089	6,585	2,442	3,078	1,389	1,593	2,028	2,513	1,661	278	0	2,681
SAMOA	0	0	0	0	0	0	241	1,023	323	1,376	1,183	554	1,180
SOLOMON ISLANDS	0	2,699	0	0	30,660	28,118	3,217	0	9,186	11,249	5,429	6,512	8,215
TUVALU	0	462	1,795	467	108	491	391	439	336	197	27	55	0
USA	7,545	6,384	5,935	5,984	5,013	8,567	9,102	7,814	8,847	14,588	13,080	12,924	12,482
VANUATU	2,524	3,669	7,094	6,883	5,773	7,159	4,653	1,232	932	394	834	346	146

flag	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CHINA	16,180	16,149	14,658	17,212	5,931	4,696	14,109	18,987	28,340	21,000	19,323	22,350	15,206
CHINESE TAIPEI	59,423	51,324	41,753	56,165	23,498	33,508	29,826	64,183	63,811	67,573	43,642	43,971	50,169
COOK ISLANDS	25	0	19	195	0	6	58	169	14	50	20	42	29
FIJI	147	1,014	1,730	1,706	2,172	1,542	1,038	577	472	680	300	251	181
FSM	338	468	445	343	529	672	411	349	731	5,749	384	78	64
JAPAN	16,325	12,342	10,435	10,820	9,482	9,986	9,237	6,973	6,355	5,491	3,562	5,651	5,414
KIRIBATI	0	264	345	401	76	769	318	203	402	286	3,614	391	1,118
KOREA	22,653	26,625	30,731	18,722	9,390	7,343	11,209	14,465	18,728	18,848	19,602	20,003	20,051
MARSHALL ISLANDS	154	154	111	14	0	0	31	75	35	30	3	20	4
PALAU	0	0	0	0	0	0	0	1,058	1,031	660	0	0	0
PNG	0	0	23	0	0	0	11	0	0	0	0	0	0
SAMOA	0	0	0	0	16	0	39	123	9	18	37	0	8
SOLOMON ISLANDS	0	192	0	0	4,003	2,481	653	0	283	277	60	75	80
TUVALU	0	119	648	87	32	20	44	110	59	51	14	6	0
USA	6,749	3,494	3,771	3,368	3,569	2,915	3,242	2,111	1,664	3,009	3,437	3,735	5,224
VANUATU	3,069	1,911	3,144	3,983	1,707	5,295	4,228	5,196	4,489	3,237	2,615	2,458	2,544

Figure 20. Trends in annual estimated CPUE (MT/day) of BIGEYE TUNA in the EEZs (red) and HIGH SEAs (green) by FLEET for the core WCPFC tropical fishery (20°N–10°S), 2010-2022

Figure 20 continued.

Figure 21. Trends in annual estimated CPUE (MT/day) of YELLOWFIN TUNA in the EEZs (red) and HIGH SEAs (green) by FLEET for the core WCPFC tropical fishery (20°N–10°S), 2010-2022

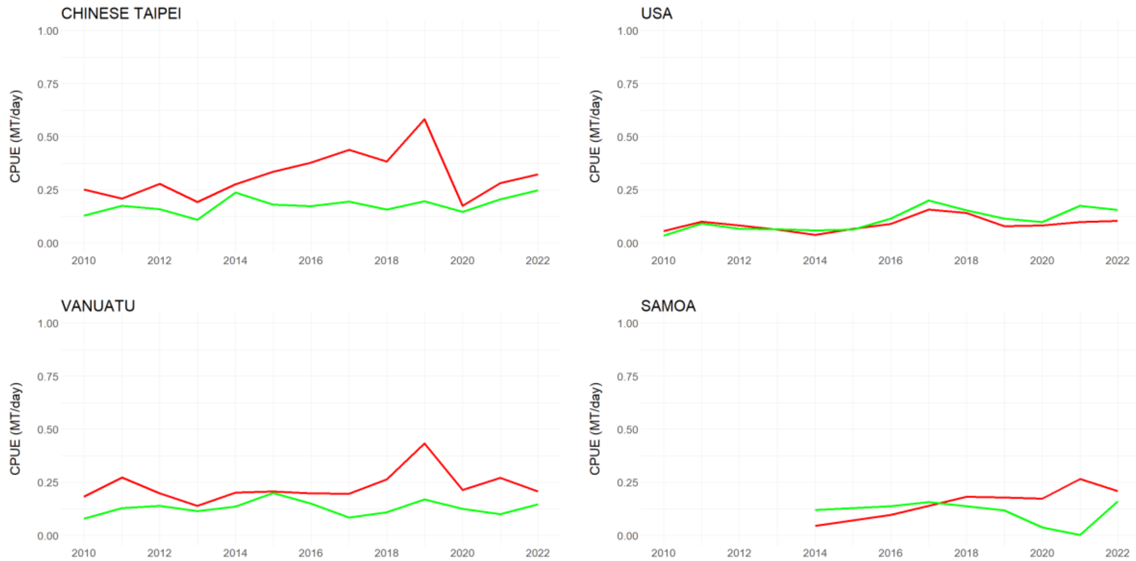

Figure 21 continued.

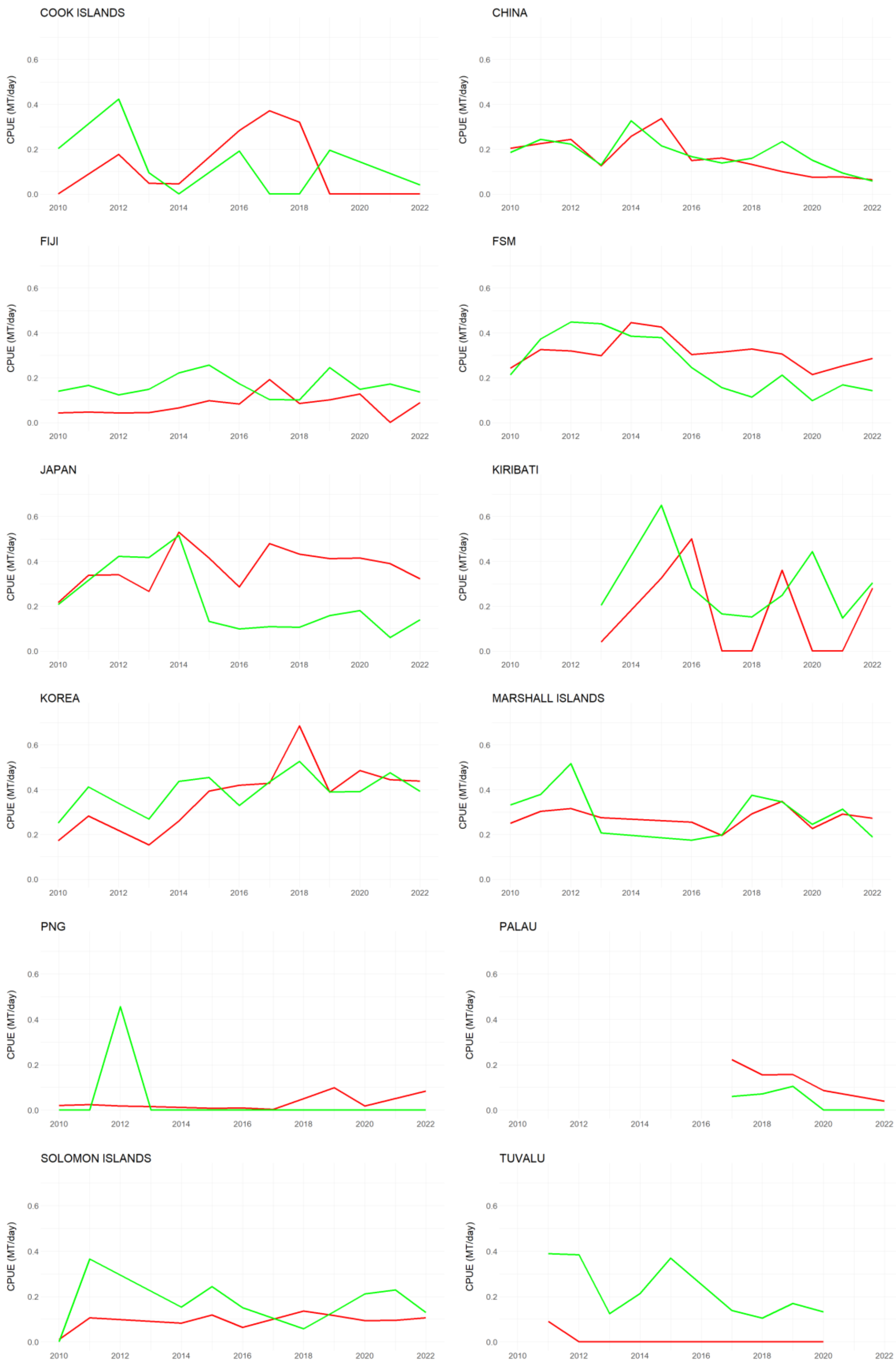

Figure 22. Trends in annual estimated CPUE (MT/day) of BIGEYE TUNA in the EEZs (red) and HIGH SEAs (green) by FLEET for the WCPFC tropical fishery (20°N–10°S), west of 170°E for the period 2010-2022

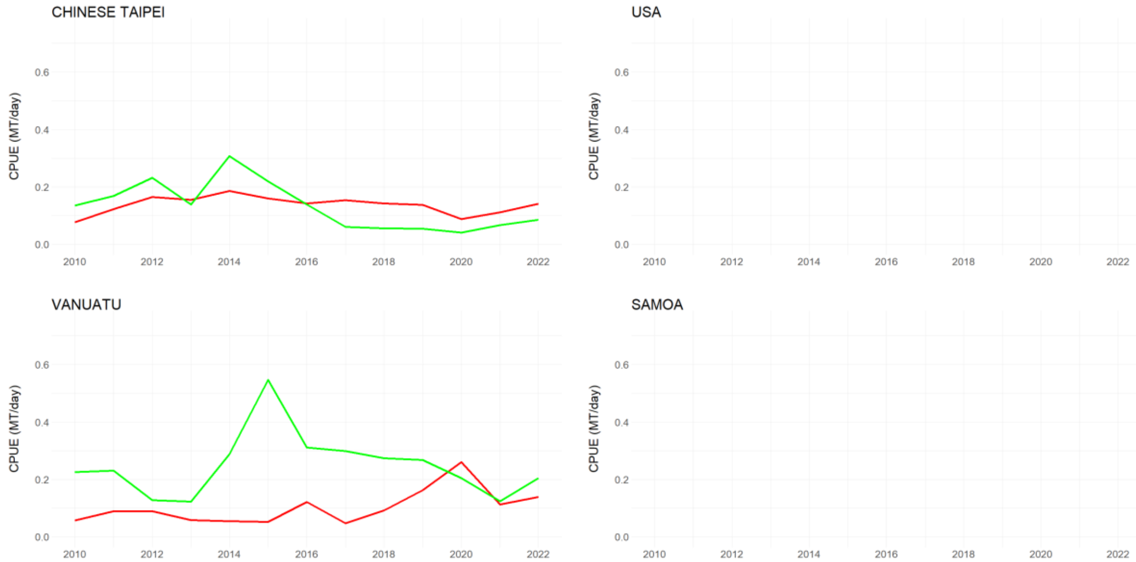

Figure 22 continued.

Figure 23. Trends in annual estimated CPUE (MT/day) of BIGEYE TUNA in the EEZs (red) and HIGH SEAs (green) by FLEET for the WCPFC tropical fishery (20°N–10°S), east of 170°E for the period 2010-2022

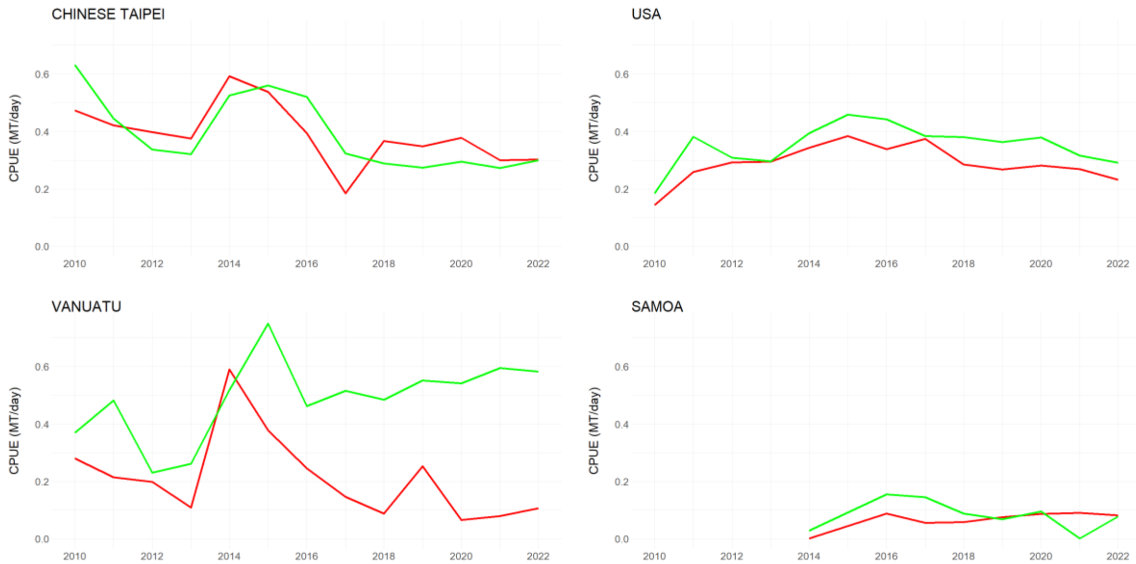

Figure 23 continued.

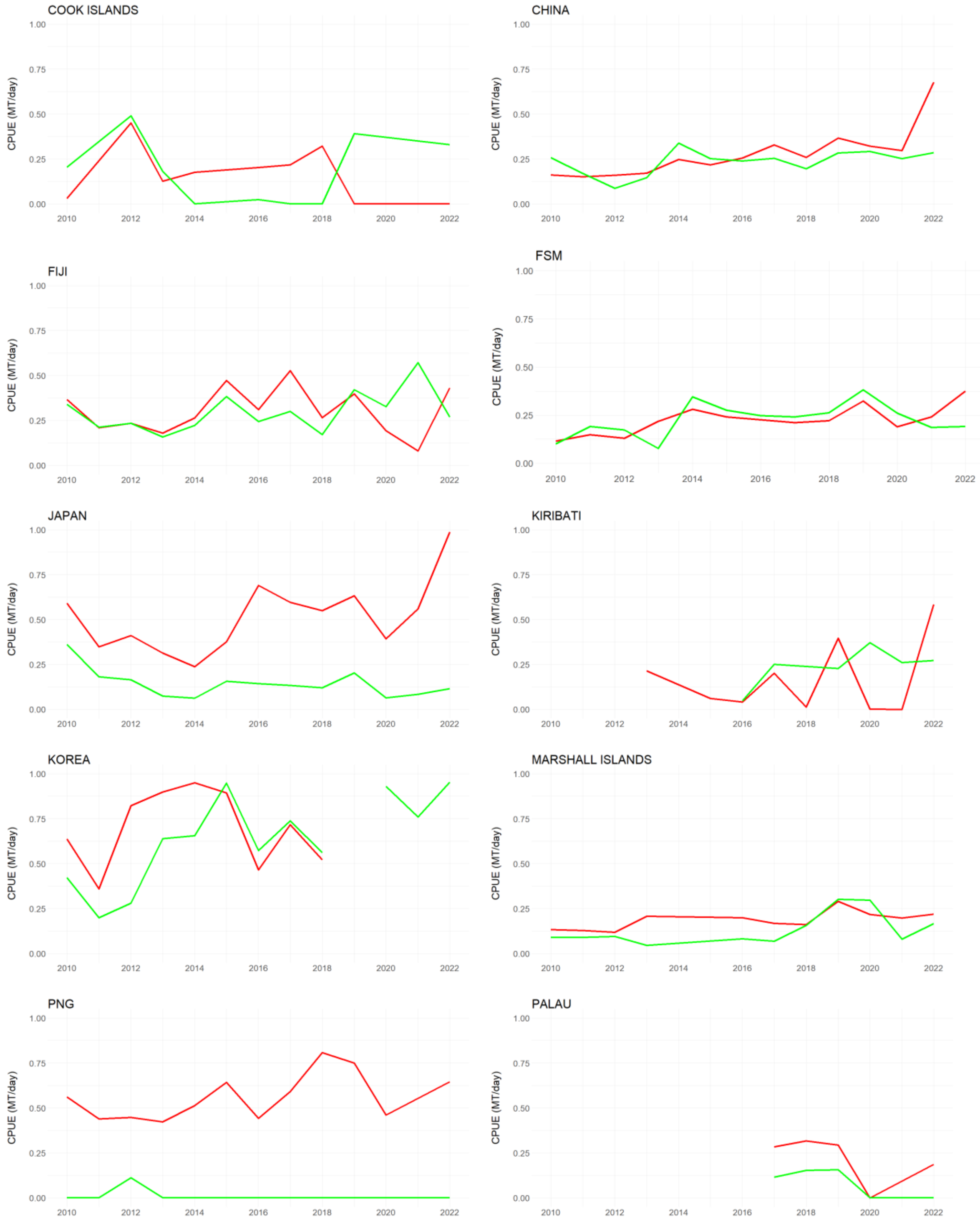

Figure 24. Trends in annual estimated CPUE (MT/day) of YELLOWFIN TUNA in the EEZs (red) and HIGH SEAs (green) by FLEET for the WCPFC tropical fishery (20°N–10°S), west of 170°E for the period 2010-2022

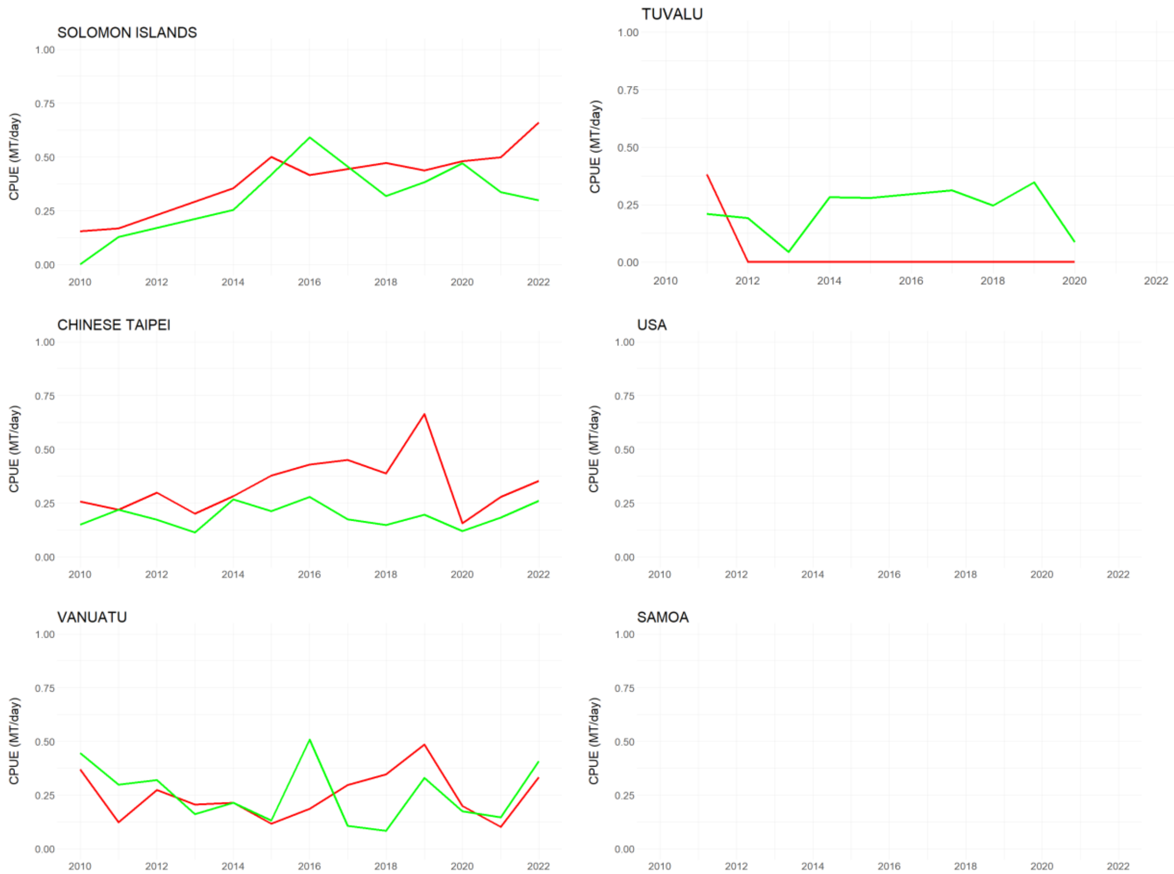

Figure 24 continued.

Figure 25. Trends in annual estimated CPUE (MT/day) of YELLOWFIN TUNA in the EEZs (red) and HIGH SEAs (green) by FLEET for the WCPFC tropical fishery (20°N–10°S), east of 170°E for the period 2010-2022

Figure 25 continued.

Appendix 1. Rankings from CCMs on the requests from TTMW3 to SSP

The table below contains the requests to the Scientific Services Provider that were revised on-screen at the TTMW3 meeting on 28 June. An additional column has been included on "rankings" which reflects the rankings received as at 9.30am Pohnpei time on 29 June 2023.

Each CCM or groups of CCMs was requested to fill in the ranking for each of their own requests (ie not the requests of other CCMs or groups of CCMs). Rankings were requested in order of priority with 1 being the highest priority.

Summary table of SSP requests from TTMW3

SSP categorisation	Request to SPC	CCM/Observer	Points	Priority Rank (1 being the highest)	Notes
Trade-offs	Produce the usual depletion/risk matrices (nuclear grid) for BET and YFT based on LL and PS scalers using the 2023 assessment grids.	US	-		Will underpin a lot of the other requests. SSP views as key. Note status quo and MP levels
Trade-offs	Trade off between FAD closure period (EEZ/HS), and LL catch. Cf EEZ vs HS FAD closure, FAD closure and LL catch (table 9 of WCPFC-TTMW2-2021-01_rev4/ Tables 11-13 in WCPFC18-2021-15)	EU/Korea	2	**1**	
		Chinese Taipei		**1**	
Trade-offs	Identify the biomass depletion levels associated with various candidate TRPs (i.e., 2012-2015 depletion, 2004 depletion, depletion associated with a risk level, 2001-2004 average levels), and the LL/PS scalars that achieve those biomass depletion levels.	US/JP	2	**1**	

SSP categorisation	Request to SPC	CCM/Observer	Points	Priority Rank (1 being the highest)	Notes
Trade-offs	Examine the conditions necessary to achieve a BET TRP at 2012-15 depletion levels, where the FAD closure has been removed	PNA	1	**1**	
Trade-offs	Update Tables 9 and 10 of WCPFC18-2021-15 based upon the new assessment	PNA	2	**1**	
LL management	Analysis of catch, effort, and catch-per-unit-effort (in weight per day) by zone and high seas, for longline fisheries and fleets	TLL workshop	2	**1**	Note from US on ranking: this request covers two requests from the US
PS management	Examine the implications of the FAD closure on foregone catches of SKJ and YFT	PNA	2	**1**	
PS management	Provide an updated analysis on the potential level of high seas purse seine effort based on the SKJ TRP (SKJ MP output).	FFA Members	2	**1**	
PS management	Update of Tables 14 and 15 of WCPFC19-2021-15, with the updated TRP from the interim skipjack MP for the reference periods 2012, 2016-2018 and 2018-2021	FFA members	2	**1**	
PS management	Table with future purse seine scalars under current conditions, without footnote 1 exemptions, without paragraph 15 exemptions (previous paragraph 17), without HS effort by CCMs in table 2, without HS effort by CCMs not in table 2	EU	2	**2**	
PS management	Provide information to support inclusion of the catch by the Philippines in the high seas limit and how this could be implemented.	FFA members	1	**2**	Expansive query. Could estimate the catch consistent with the allocated limit as in Attachment2?

SSP categorisation	Request to SPC	CCM/Observer	Points	Priority Rank **(1 being the highest)**	Notes
PS management	Include stock projections for different scenarios of reduced FAD closure (10% 20%, 30% reduction, status quo) in their analyses to be presented to SC19.	Korea	2		Not available for SC given new BET assessment to be agreed. TTMW4 feasible
	Include stock projections for different scenarios of increased FAD closure (10%, 20%, 30% increase) in their analyses.	JP		**2**	
	What is the impact to juvenile BET and YFT from decreasing the FAD closure period in terms of $SB/SB_{F=0}$?	US		**2**	
		Chinese Taipei		**2**	
			20		
	Develop methods to convert between purse seine effort and longline catch. What does a day of fishing and sets of fishing equate to in terms of catch - both on the high seas and inside EEZs. (note also para 136 of TTMW3-2023-IP02)	US	2	**3** Post-TTMW4	Can compute PS effort v LL catch/CPUE from available aggregate level data.
	Update Table 6 and 7 of WCPFC18-2021-15 with a TRP at 2012-15 levels, without a FAD closure	PNA/JP	1	**3 (JP)** **4 (PNA)** Post-TTMW4	
	Update of data summaries as in SC18-MI-IP-08 – LL catch and PS/PL effort by area (AW, EEZ, HSP, other HS) and HS v flag	EU	1	Post-TTMW4	Update with latest information as needed

SSP categorisation	Request to SPC	CCM/Observer	Points	Priority Rank (1 being the highest)	Notes
	Updated figures 9 and 10 of SC18-MI-IP08 with PS effort in waters under national jurisdiction (EEZs and AWs), in the HS by CCMs in table 2 of CMM, in the HS by the Philippines, in the HS by Pacific Island fleets fishing in high seas adjacent to their home waters during the HS closures, in the HS by CCMs not listed in Table 2 (not including the effort already included in the previous item).	EU	1	Post-TTMW4	Time required reduced based upon EU clarification
			5		

Total points available prior to TTMW4 = **20**

Total points do not include the development of the 'nuclear grid' – one key large item – which will underpin the work on many other requests, and hence is viewed by the SSP as high priority and necessary for delivery.