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The fitting results of ASAP to pseudo data and performance measures for operating model of Chub mackerel

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Summary

This document showed the results of ASAP (age-structured assessment program) fitting to pseudo data (catch at age and six abundance indices), with the performance measures. Almost ASAP converged (2303 of 2400 basic runs and 463 of 480 retrospective analysis), with good model fitting and relatively low Mohn's ρ values. Compare with ASAP based on real data, results from pseudo data have higher *TB*, SSBmedian-depletion; lower *E*, Bmax-depletion, Bmsy_0.7 and Bmsy_0.9; similar *R*, Bmedian-depletion, F-related BRPs and RFI. How to interpret the results and to evaluate the model performance is complex and difficult, requiring much discussion during the TWG CMSA06.

Introduction

To select the best model(s) used for Chub mackerel stock assessment and management, the operating model has been conducted. As one step of operating model construction, those five stock assessment model candidates (ASAP, SAM, VPA, ASAP and KAFKA) should be fitted to the pseudo data simulated based on PopSim by Dr. Joel Rice. The performance measures are also required to be calculated and compared. This document showed the results of ASAP (age-structured assessment program) fitting to pseudo data, with its performance measures.

Materials and Methods

The data derived from pseudo data and used for ASAP, includes:

1) Catch at age (catNumByAgeTot)
2) Six abundance indices (Number of total for fleet 1,2, and MTtotal for fleet 3,4,5,6), i.e.
    a) Japanese summer recruitment survey (2002-2019)
    b) Japanese autumn recruitment survey (2005-2019)
    c) Japanese fishery-independent egg survey for biomass estimates (2005 to 2019),
    d) Japanese dip-net fishery CPUE (2003-2019),
    e) Chinese fishery CPUE (2015-2019)
    f) Russian fishery CPUE (2016-2019)

The abundance index was scaled by mean, to be consistent. All other model structure, settings, initial default were same as the ASAP based on the real data.

The pseudo data has 6 scenarios (A, B, C, D, E and F), with 400 iterations for each scenario. To save time, retrospective analysis was not conducted for all those 400*6 iterations. According to the agreement of SWG OM03, 80 iterations from each scenario, were provided by Dr. Joel Rice and conducted for retrospective analysis by each candidate model. Only results from the converged iterations were summarized, and compared with those from the ASAP based on the real data.

The performance measures were calculated, including state (total biomass TB, fishing mortality *F*, exploitation rate *E* and recruitment *R* of whole years), depletion (the max and median *B* and spawning stock biomass SSB of each decade), biological reference points (related *B*, SSB and *F*), relative fishing impact, and retrospective analysis (Mohn's ρ of weighted fishing mortality AFy, spawning biomass SBy, and TBy). The assumptions, methods, and equations of performance measures are referred to the agreed file, i.e. *Detailed configurations for calculating performance measures*.

Results and Discussion

Among those 400*6 iterations, 97 iterations (<0.1%) were not fitted converged by ASAP basic run, while 17 iterations (<0.1%) of 80*6 iterations were not converged in the retrospective analysis (Table 1). Non-converged iterations of the sensitivity scenarios (C:F) were less than those of the base case scenarios (A and B)

Compare with ASAP based on real data, results of ASAP based on pseudo data estimated higher *TB*, lower *E*, similar *R*, for all scenarios, while the comparison for *F* was different among years (Figures 1-6). For depletion, estimates from pseudo data had lower Bmax, close Bmedian, except Bmedian_1990, complex SSBmax and much higher SSBmedian (Figure 7). The biological reference points BRP during years 2016-2018 and 2017-2019 are much similar, while *B* and SSB related BRPs are same. There are much outliers for Bmsy_HS, and lower Bmsy_0.7 and Bmsy_0.9 estimates. The F-related BRPs and RFI are much closer with those based on real data, except Fmsy_HS (Figures 8 and 9).

Results of retrospective analysis indicated that the median Mohn's ρ values of AFy (-0.24~-0.07) and TBy (0.14~0.40) are lower, which of SBy (0.04~0.29) were higher (Figure 10). No significant retrospective pattern was revealed for most iterations, indicated good fitting and projection ability. Since the pseudo data from different models (ASAP, KAFKA, SAM and SAM) were mixed and blind, there are wide confidence interval of model results. How to evaluate the model performance based on self-testing and cross-testing, would be up to outcomes of the invited expert.

Acknowledgement

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References

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Tables

Table 1 The iteration no. that didn’t converge during ASAP fitting to the pseudo data

Scenario	A	B	C	D	E	F
Basic run not converge	12	13	57	12	9	16
	25	14	108	21	44	24
	34	18	110	83	68	66
	47	60	116	100	96	105
	60	92	157	152	124	170
	72	111	185	153	182	180
	93	151	193	156	184	187
	173	176	197	172	198	192
	175	190	201	176	223	201
	202	212	332	203	224	247
	215	213	334	256	248	311
	224	236	348	278	275	
	226	238	375	283	280	
	276	239	399	376	313	
	289	241			320	
	310	298			325	
	327	317			363	
	330	318			392	
	376	341				
	382	358				
Retrospective analysis not converge	34	14	157	176	9	24
	72	92		256	68	105
	226	111			320	
	276	176				
		190				

Figures

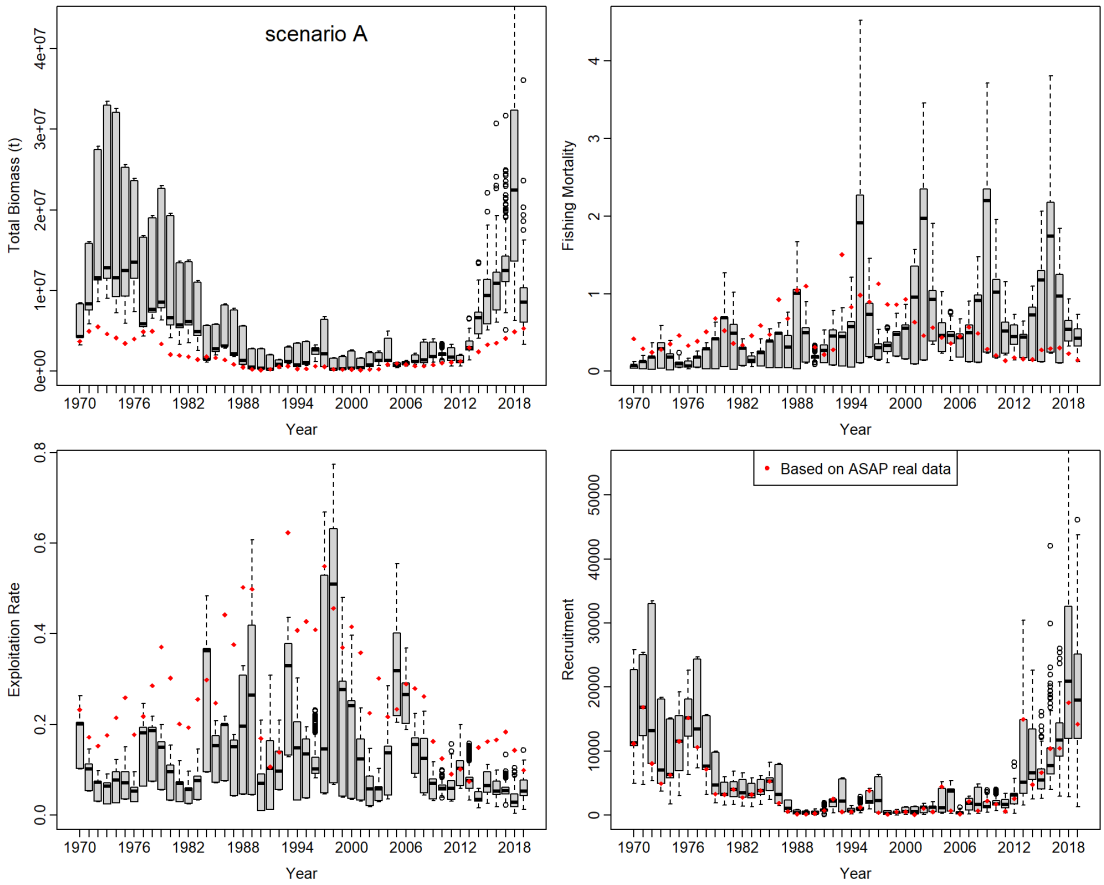

Figure 1 The total biomass, fishing mortality, exploitation rate and recruitment estimated from ASAP scenarios A fitting to the pseudo data

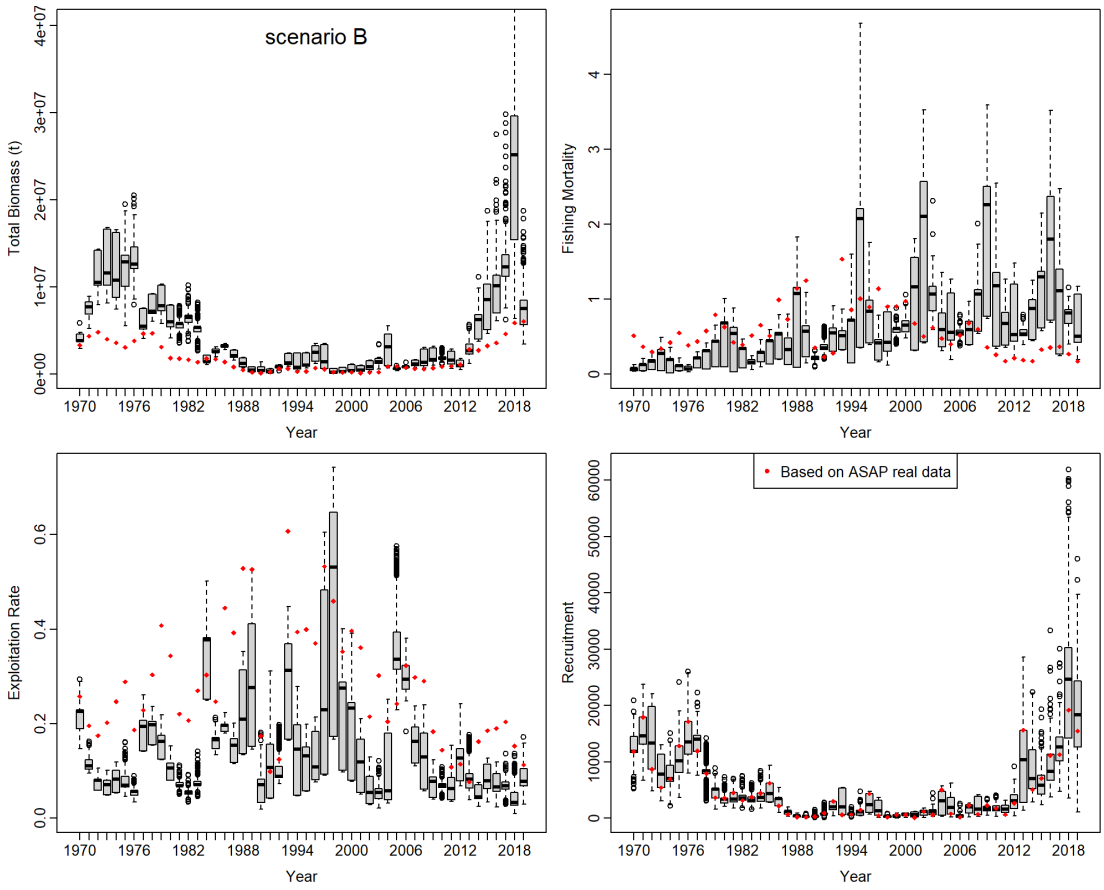

Figure 2 The total biomass, fishing mortality, exploitation rate and recruitment estimated from ASAP scenarios B fitting to the pseudo data

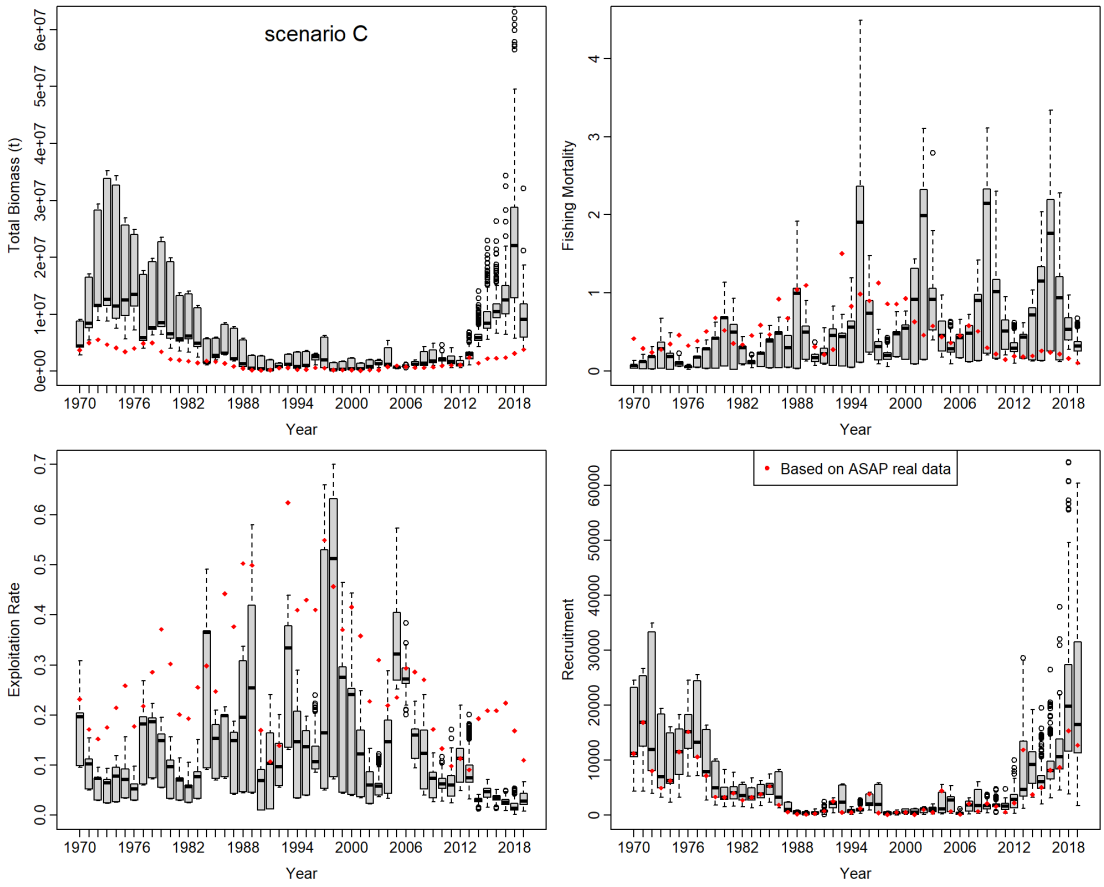

Figure 3 The total biomass, fishing mortality, exploitation rate and recruitment estimated from ASAP scenarios C fitting to the pseudo data

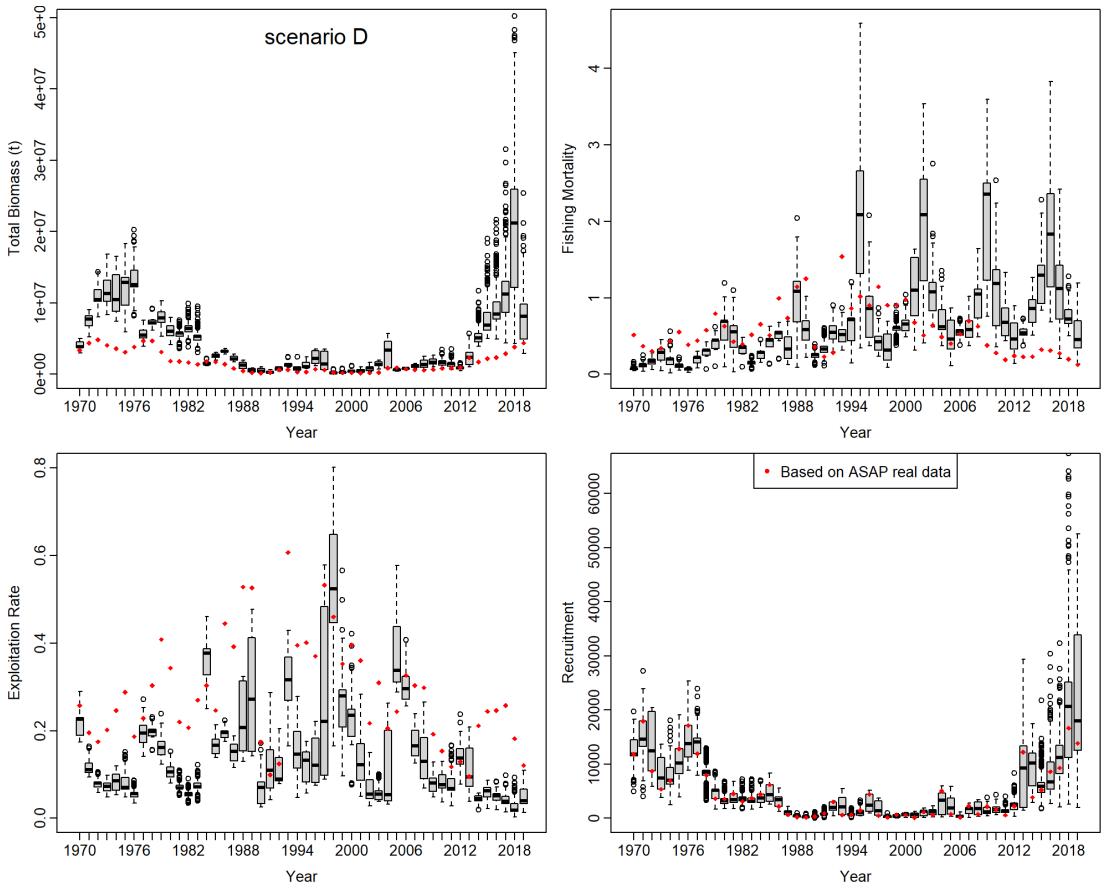

Figure 4 The total biomass, fishing mortality, exploitation rate and recruitment estimated from ASAP scenarios D fitting to the pseudo data

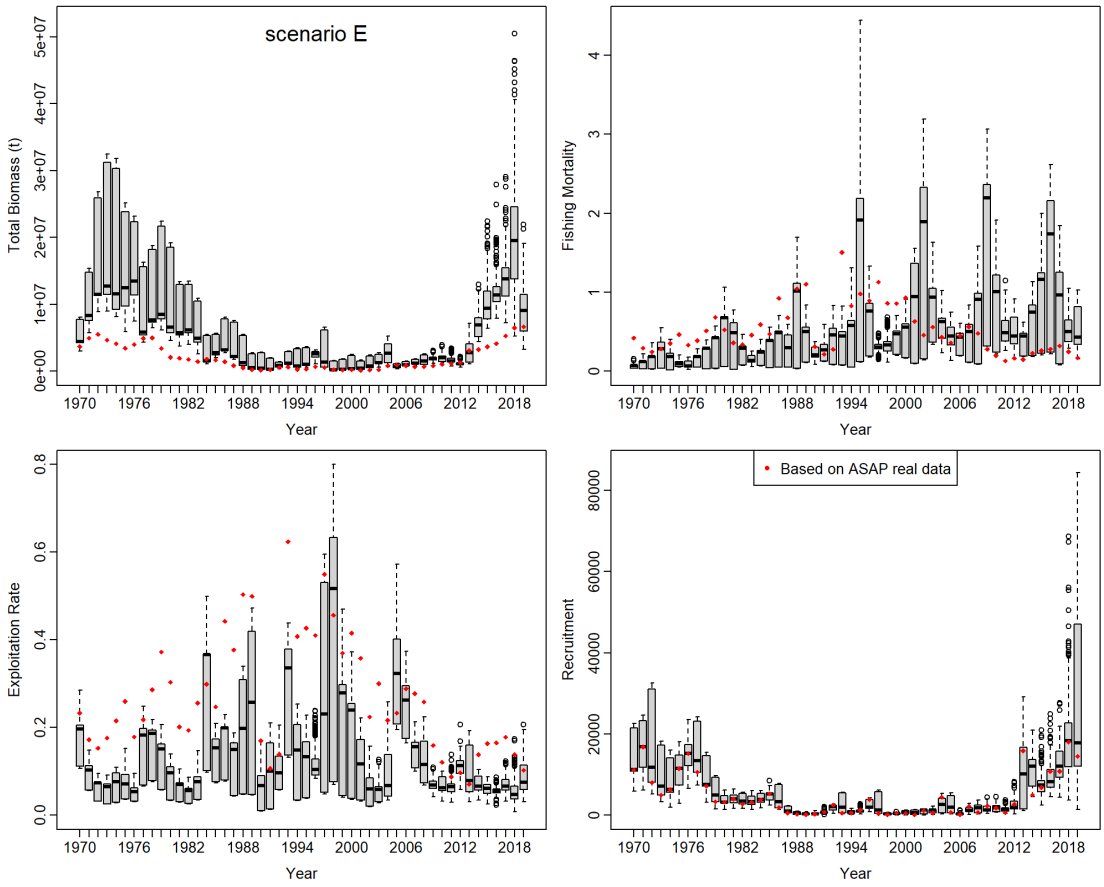

Figure 5 The total biomass, fishing mortality, exploitation rate and recruitment estimated from ASAP scenarios E fitting to the pseudo data

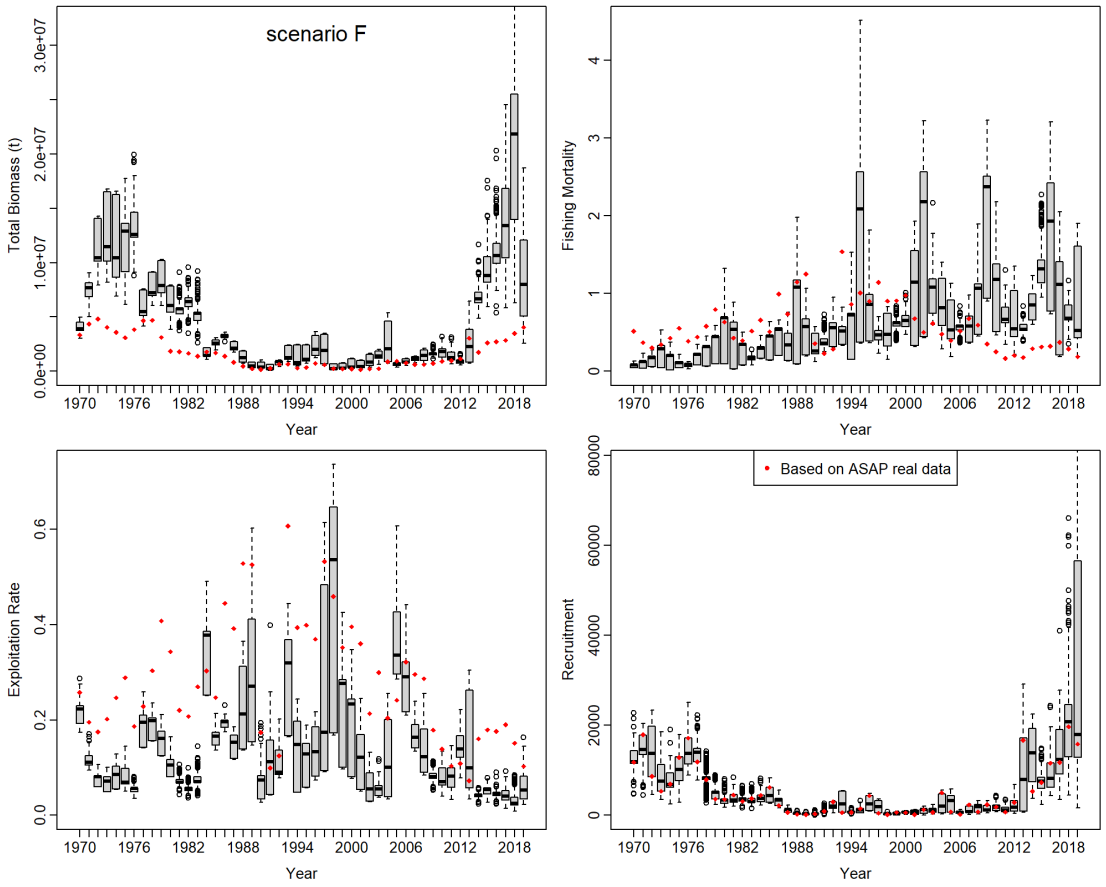

Figure 6 The total biomass, fishing mortality, exploitation rate and recruitment estimated from ASAP scenarios F fitting to the pseudo data

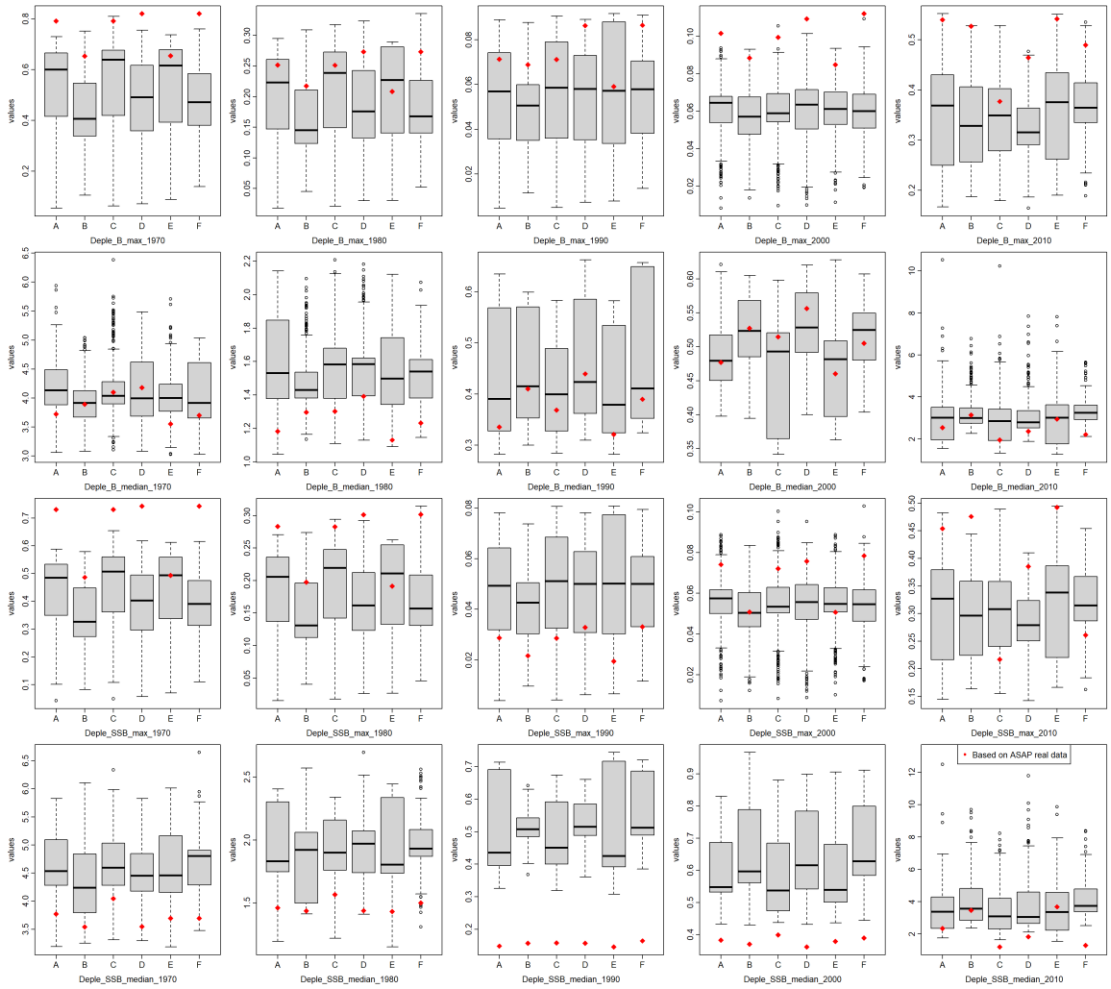

Figure 7 The depletion (B_{max}, B_{median}, SSB_{max}, and SSB_{median} of different decades) estimated from ASAP 6 scenarios (A:F) fitting to the pseudo data

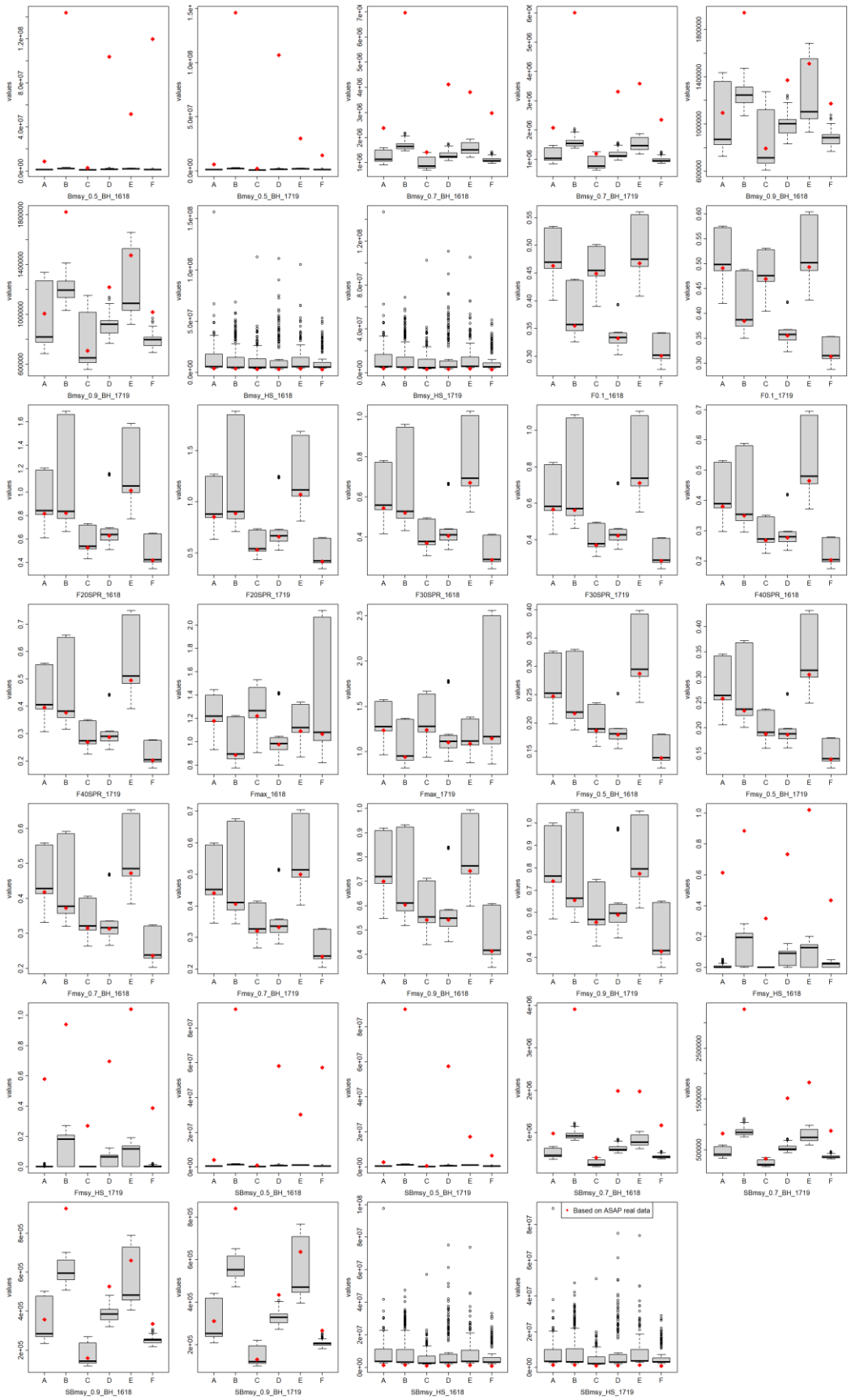

Figure 8 The biological reference points estimated from ASAP 6 scenarios (A:F) fitting to the pseudo data

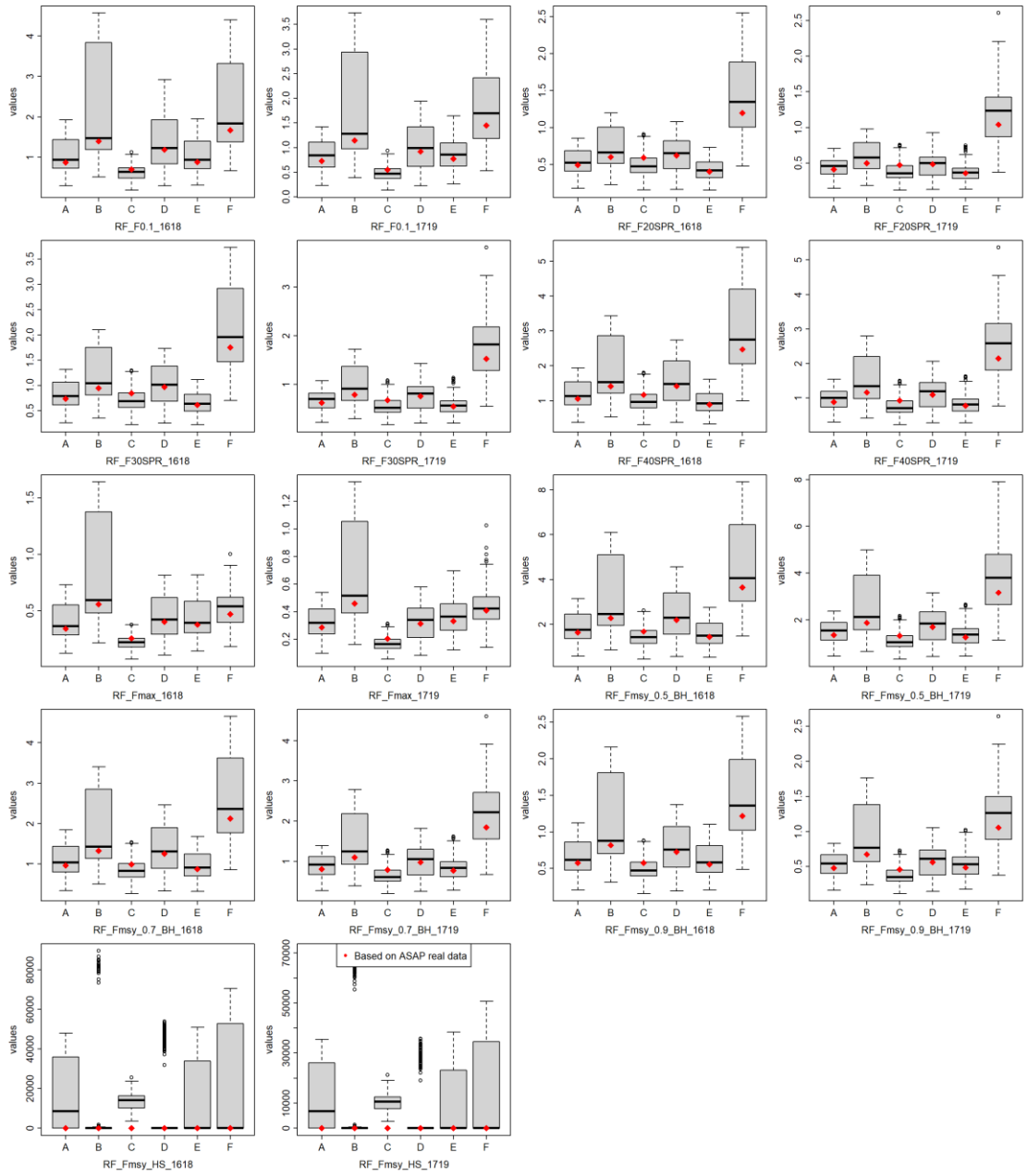

Figure 9 The relative fishing impact estimated from ASAP 6 scenarios (A:F) fitting to the pseudo data

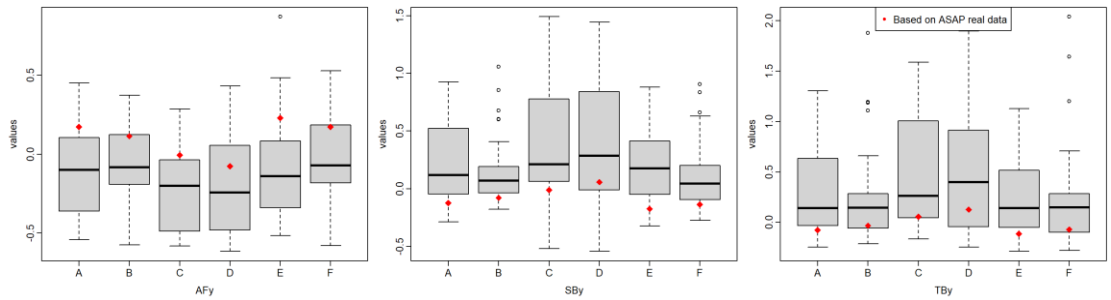

Figure 10 The Mohn's ρ values of weighted fishing mortality AFy, spawning biomass SBy, and total biomass TBy from retrospective analysis of ASAP 6 scenarios (A:F) fitting to the pseudo data