

# Supplemental Materials for Data Rich but Model Resistant: An Evaluation of Data-Limited Methods to Manage Fisheries with Failed Age-based Stock Assessments

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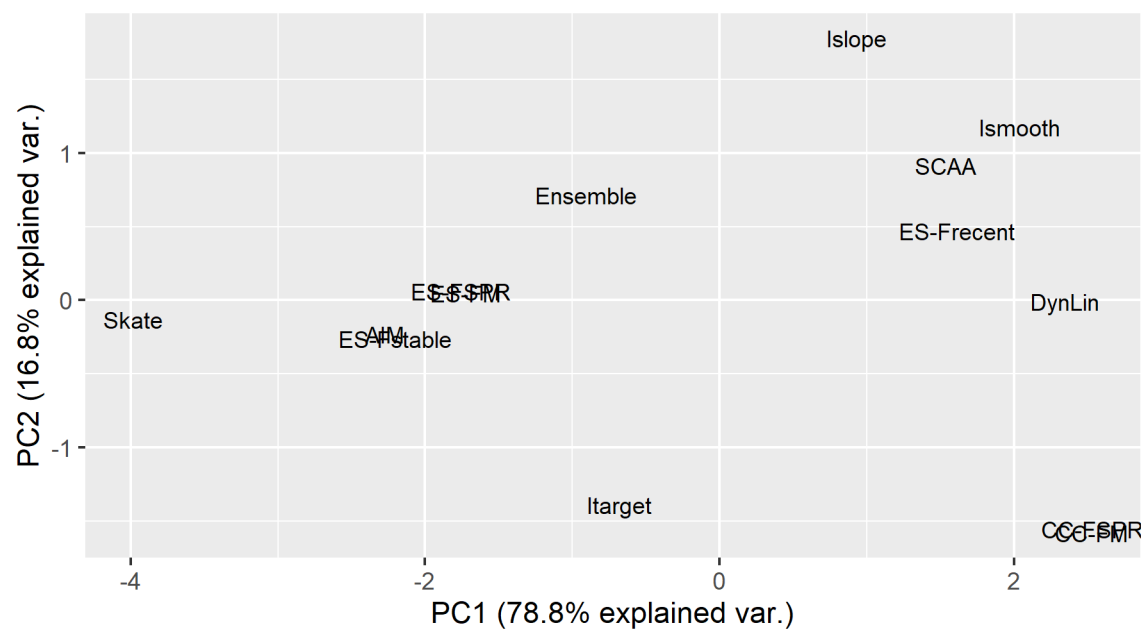
<sup>7</sup>Mid-Atlantic Fishery Management Council, Dover, DE, USA

*Add Figure 1.2 from report* (addresses reviewer comment about distribution of Mohn's rho) Distribution of 50 Mohn's rho values for no misspecification (top row), catch misspecification (middle row), and natural mortality misspecification (bottom row) for spawning stock biomass (SSB), fishing mortality rate ( $F_{bar}$ ), and recruitment (R). Panels are defined by retrospective type (none, catch, natural mortality), fishing intensity (1=always overfishing, 2=overfishing reducing to  $F_{msy}$ ), and number of selectivity blocks (1 or 2).

*Add Figure 1.5 from report* (addresses reviewer comment about scenario set ups) Fishing mortality rate ( $F$ ) during the base period (black line) for the 8 combinations of  $F$  history ( $F = F_{msy}$  in second half of base period,  $O =$  overfishing throughout), number of fishery selectivity blocks (1 or 2), and retrospective source (catch or natural mortality,  $M$ ). The horizontal blue line denotes the  $F$  at maximum sustainable yield ( $F_{msy}$ ) computed from conditions in the first year of the base period (1970) while the red dashed horizontal line denotes the  $F_{msy}$  computed from conditions in the terminal year in the base period (2019).

*Add Figure 1.6 from report* (addresses reviewer comment about scenario set ups) Spawning stock biomass (SSB) relative to the SSB at maximum sustainable yield ( $SSB_{msy}$ ) computed from the conditions in the terminal year in the base period (2019) with the median value shown as the black line, the interquartile range shown in light grey, and the 95% range shown in dark grey for the 8 combinations of  $F$  history ( $F = F_{msy}$  in second half of base period,  $O =$  overfishing throughout), number of fishery selectivity blocks (1 or 2), and retrospective source (catch or natural mortality,  $M$ ).

*Add Figure 4.15 from report* (addresses reviewer comment about no retro results) Mean spawning stock biomass (SSB) relative to the SSB at maximum sustainable yield ( $SSB_{msy}$ ) and catch relative to  $MSY$  for 3 sources of retrospective pattern (catch, natural mortality ( $M$ ), and none) and two fishing histories ( $F$  and  $A$ ) in the long term based on 1,000 simulations.



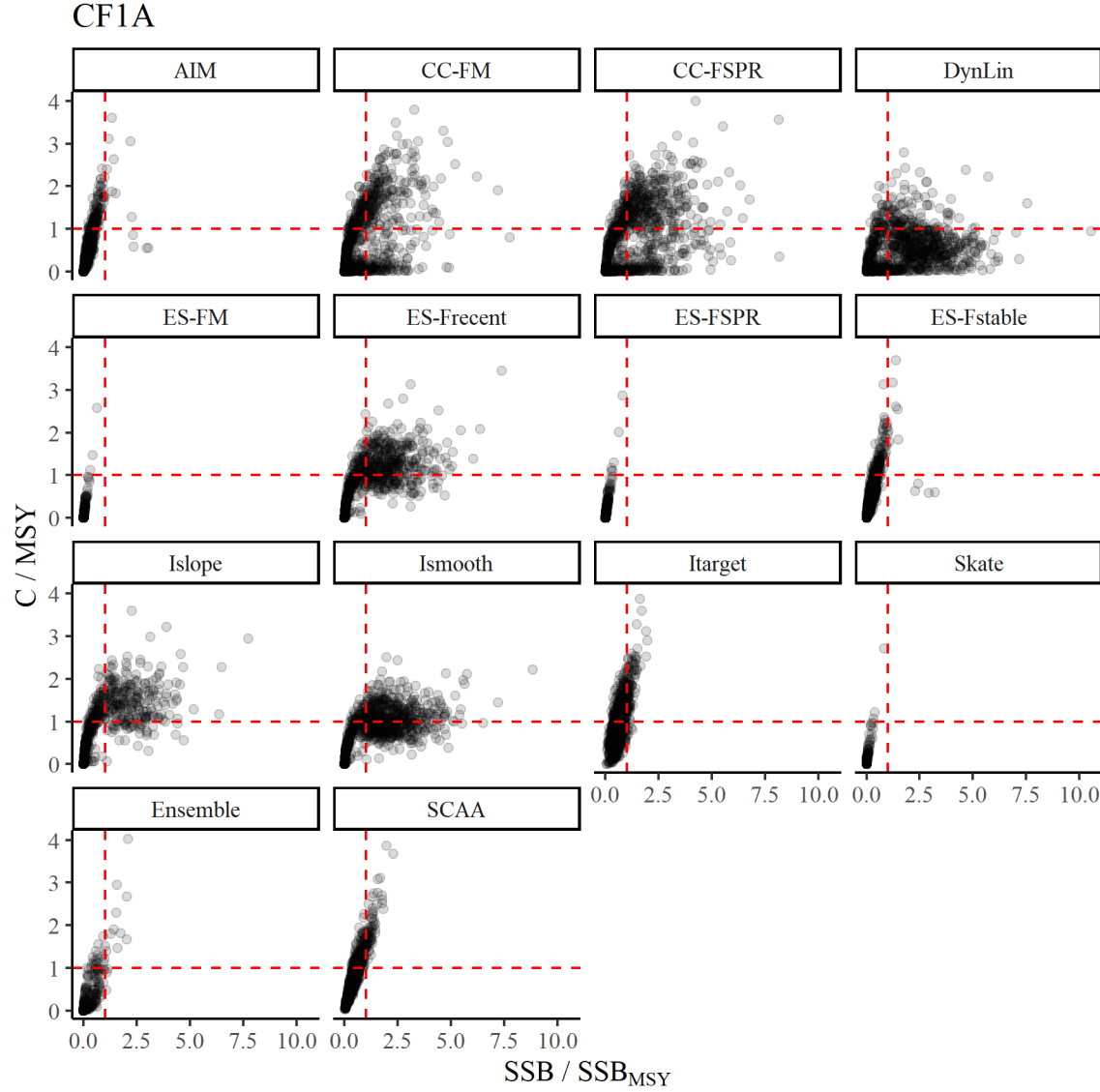


Figure S6. Relationship between long-term average catch and spawning stock biomass relative to their reference points by method. Each point represents the average for years 21-40 in the feedback period for a single iteration of a scenario. The scenario shown is where catch was the source of the retrospective pattern with  $F$  reduced to  $F_{MSY}$  in the second half of the base period, there was a single selectivity block, and where no buffer was applied to the catch advice (catch multiplier = 1).

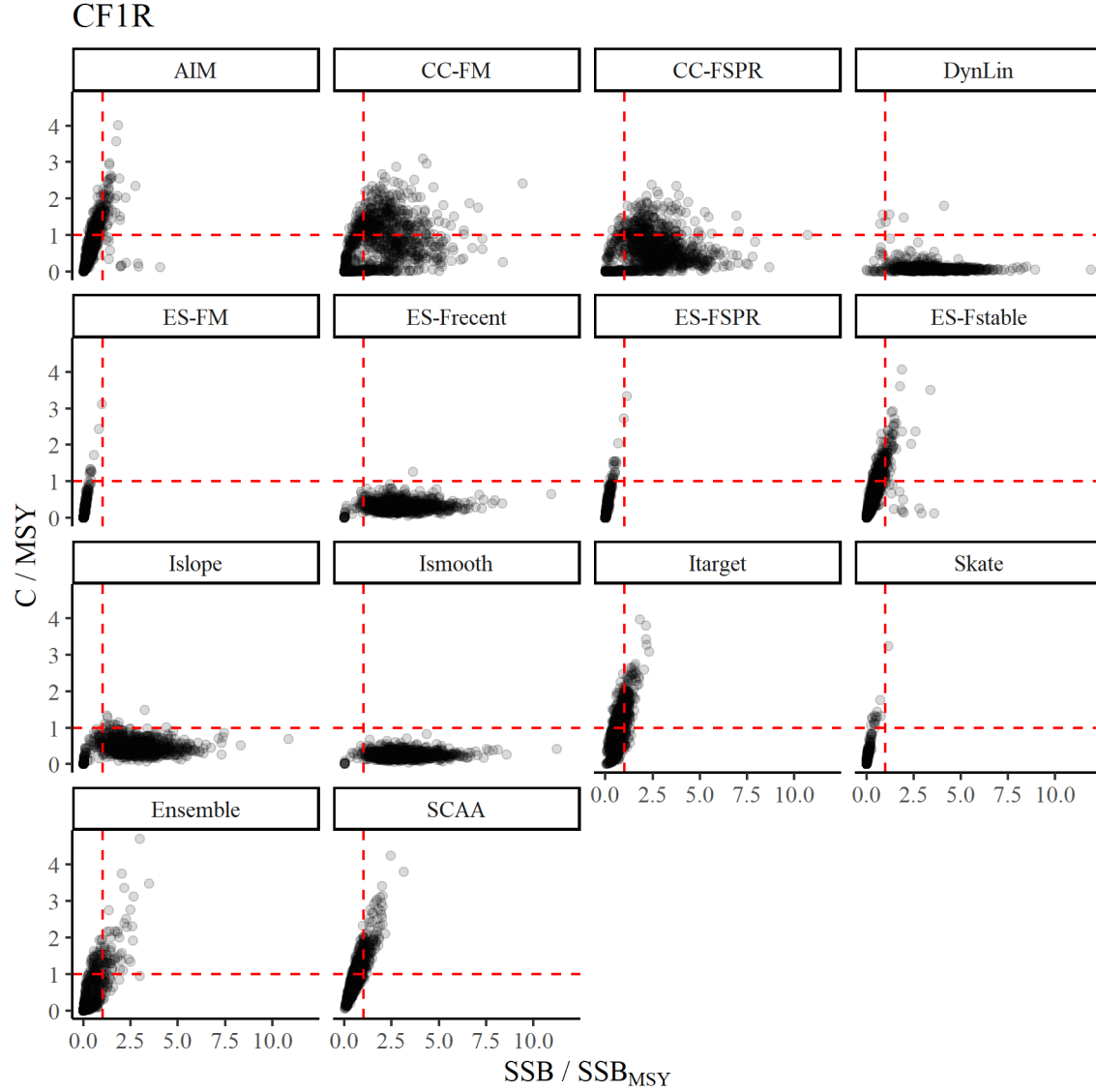


Figure S7. Relationship between long-term average catch and spawning stock biomass relative to their reference points by method. Each point represents the average for years 21-40 in the feedback period for a single iteration of a scenario. The scenario shown is where catch was the source of the retrospective pattern with  $F$  reduced to  $F_{MSY}$  in the second half of the base period, there was a single selectivity block, and where a buffer was applied to the catch advice (catch multiplier = 0.75).

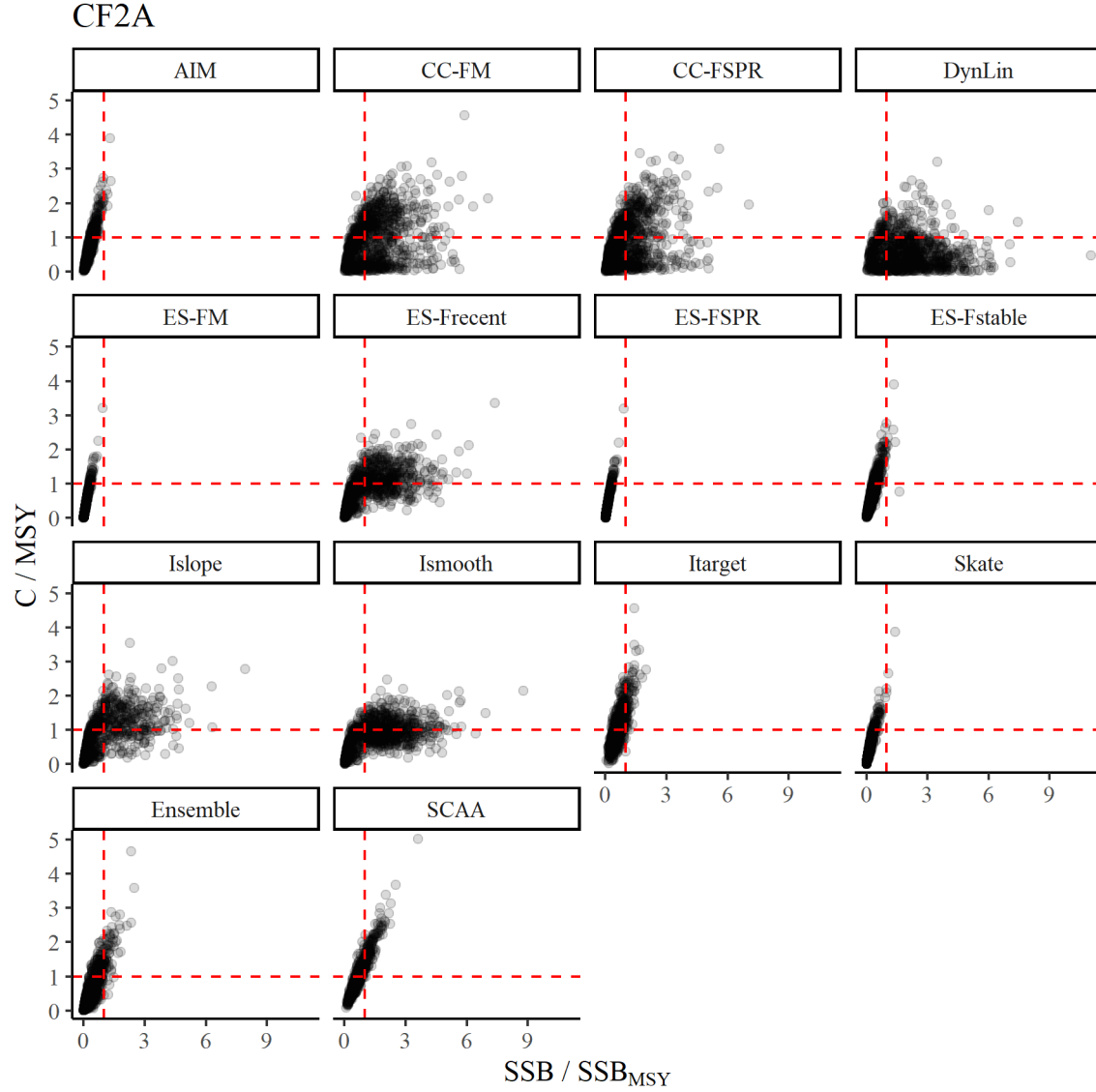


Figure S8. Relationship between long-term average catch and spawning stock biomass relative to their reference points by method. Each point represents the average for years 21-40 in the feedback period for a single iteration of a scenario. The scenario shown is where catch was the source of the retrospective pattern with  $F$  reduced to  $F_{MSY}$  in the second half of the base period, there were two selectivity blocks, and where no buffer was applied to the catch advice (catch multiplier = 1).

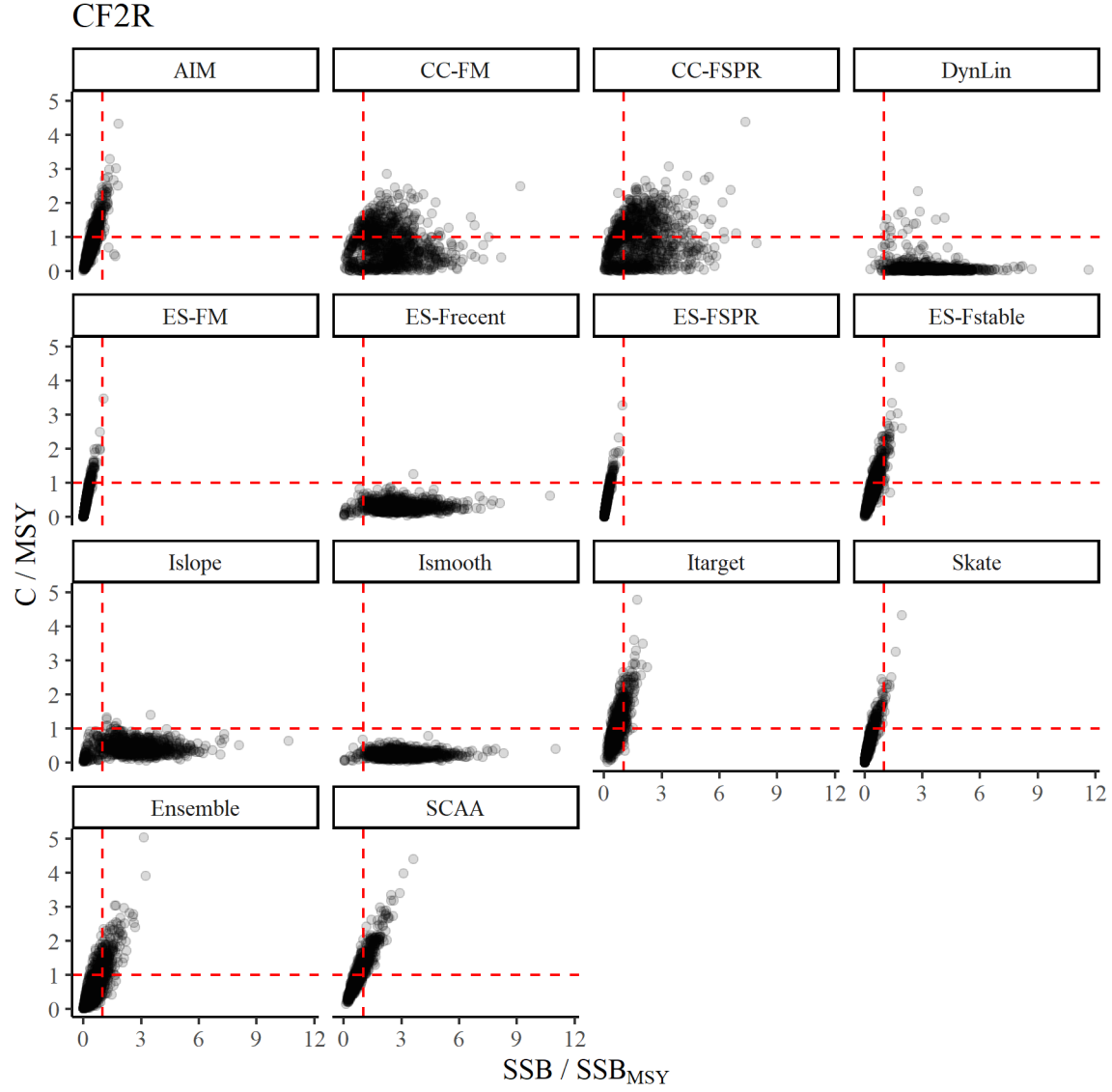


Figure S9. Relationship between long-term average catch and spawning stock biomass relative to their reference points by method. Each point represents the average for years 21-40 in the feedback period for a single iteration of a scenario. The scenario shown is where catch was the source of the retrospective pattern with  $F$  reduced to  $F_{MSY}$  in the second half of the base period, there were two selectivity blocks, and where a buffer was applied to the catch advice (catch multiplier = 0.75).

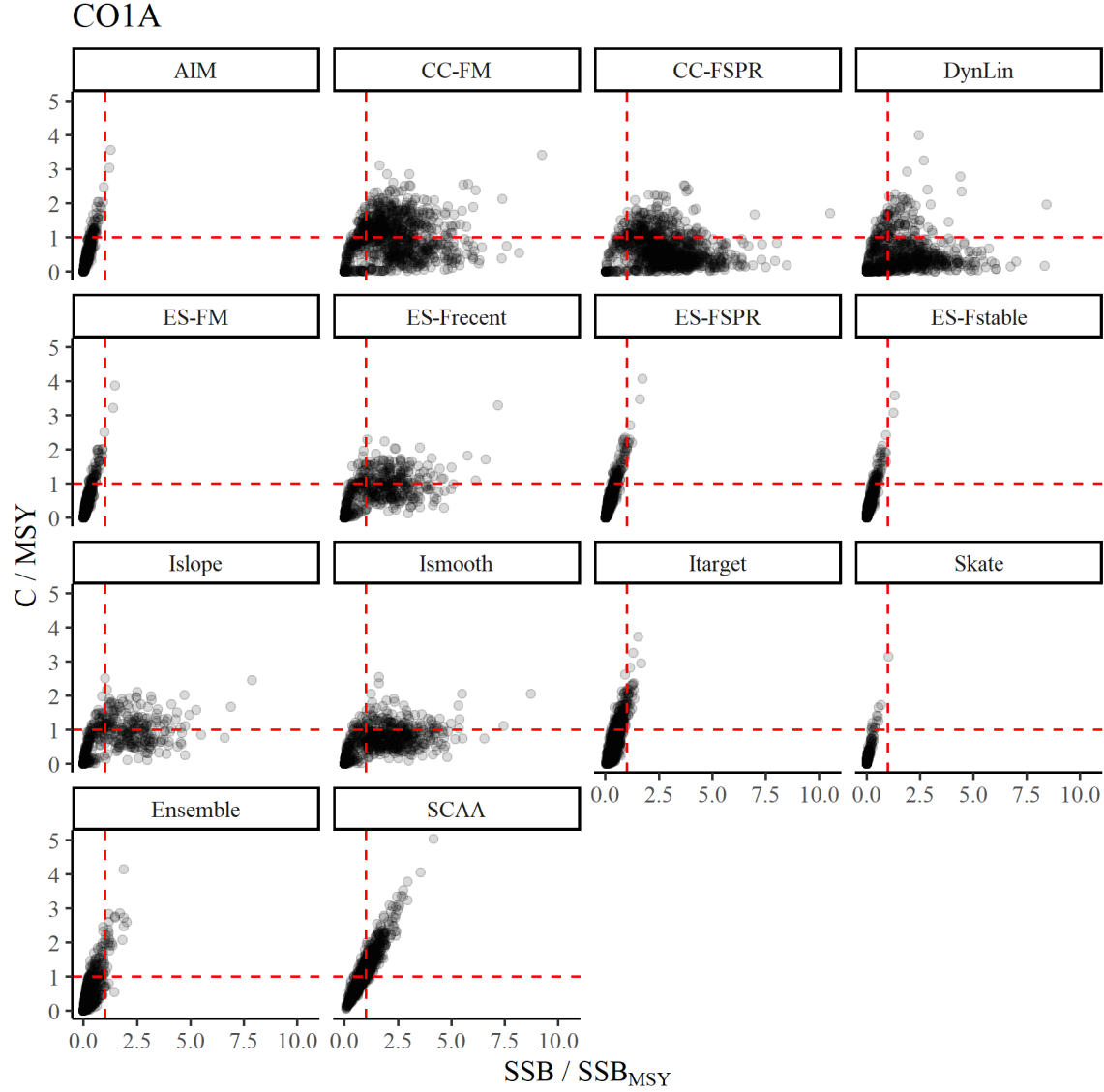


Figure S10. Relationship between long-term average catch and spawning stock biomass relative to their reference points by method. Each point represents the average for years 21-40 in the feedback period for a single iteration of a scenario. The scenario shown is where catch was the source of the retrospective pattern with  $F$  remaining at 2.5 times  $F_{MSY}$  in the second half of the base period, there was a single selectivity block, and where no buffer was applied to the catch advice (catch multiplier = 1).

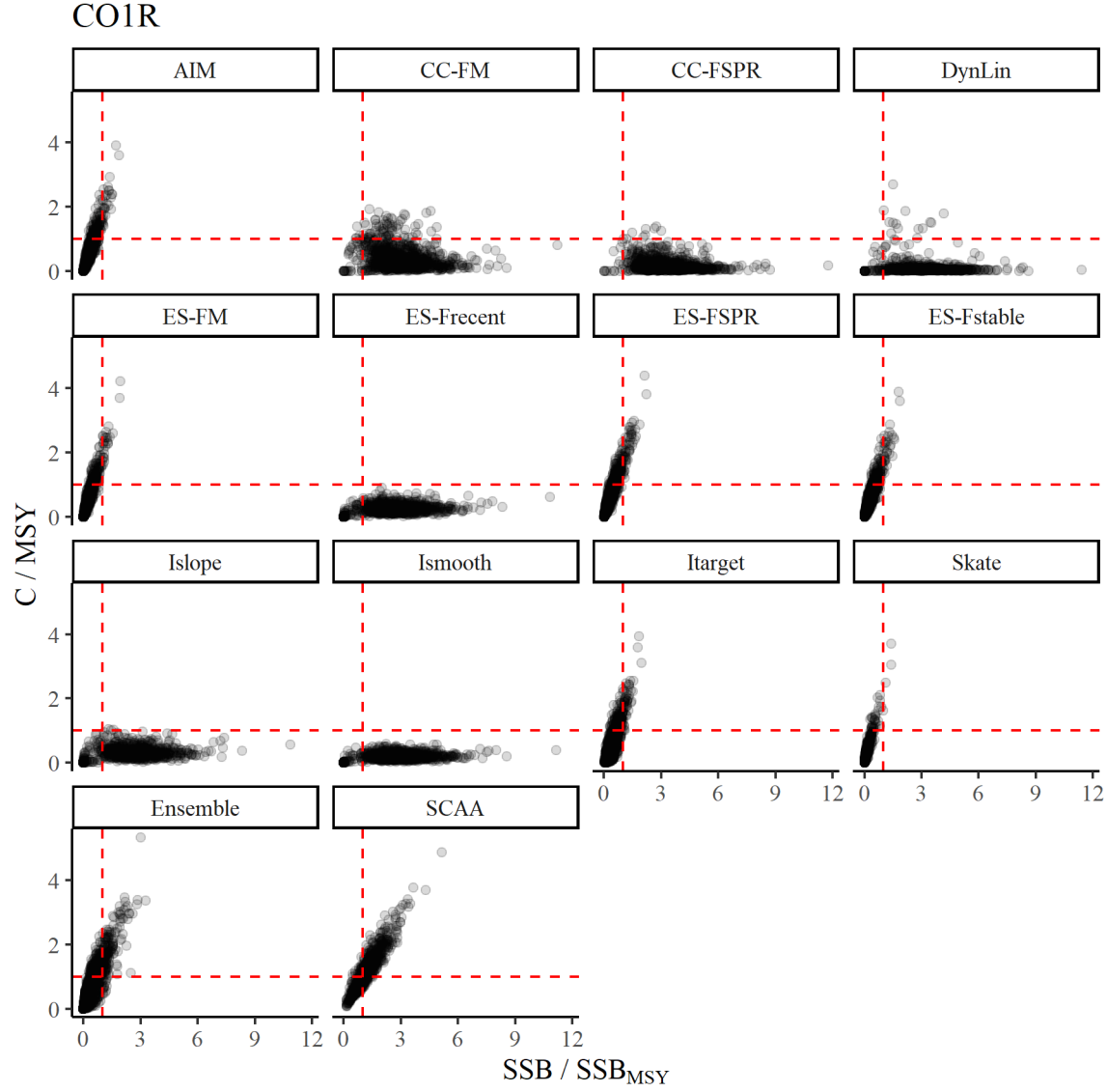


Figure S11. Relationship between long-term average catch and spawning stock biomass relative to their reference points by method. Each point represents the average for years 21-40 in the feedback period for a single iteration of a scenario. The scenario shown is where catch was the source of the retrospective pattern with  $F$  remaining at 2.5 times  $F_{MSY}$  in the second half of the base period, there was a single selectivity block, and where a buffer was applied to the catch advice (catch multiplier = 0.75).



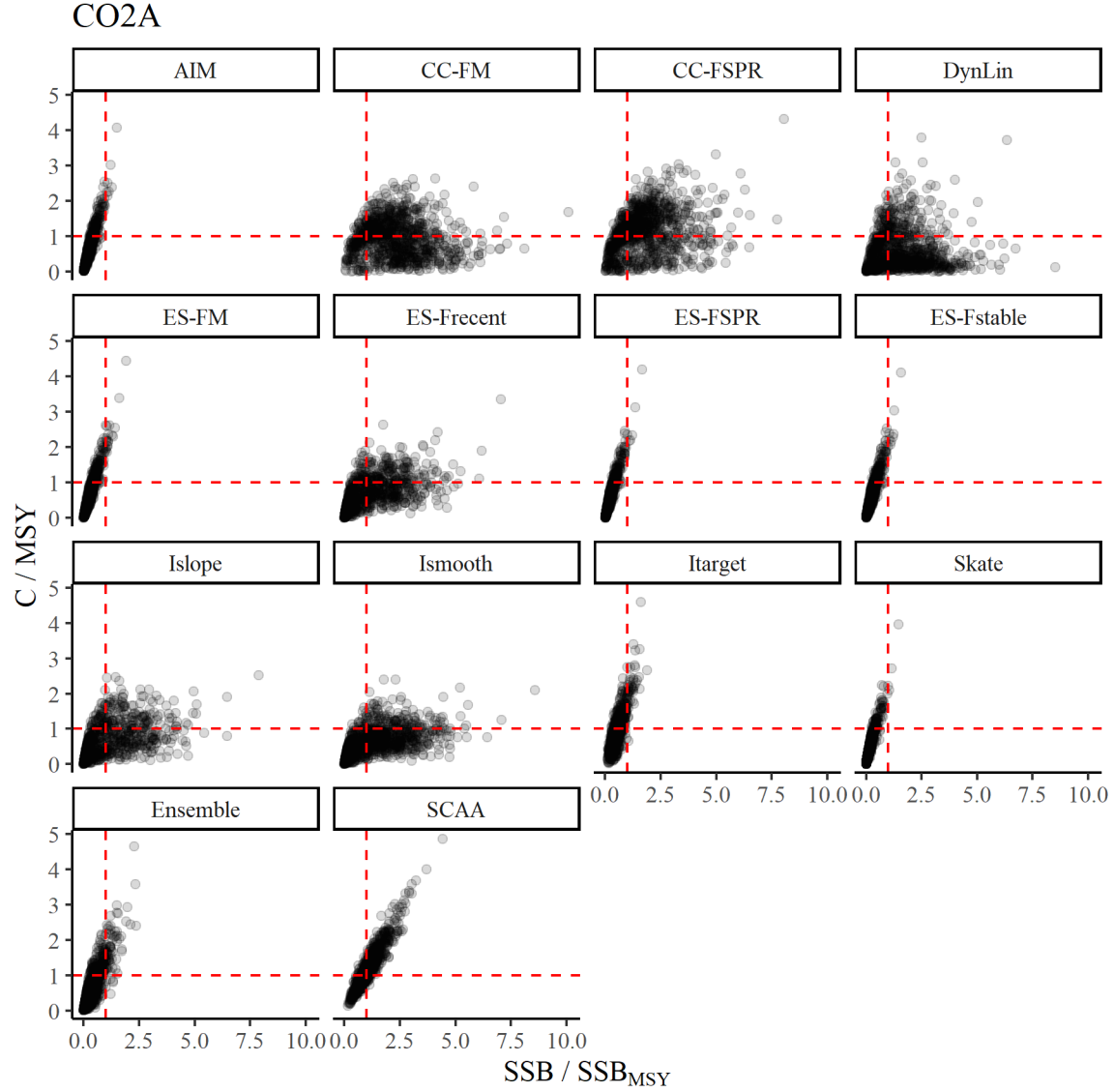


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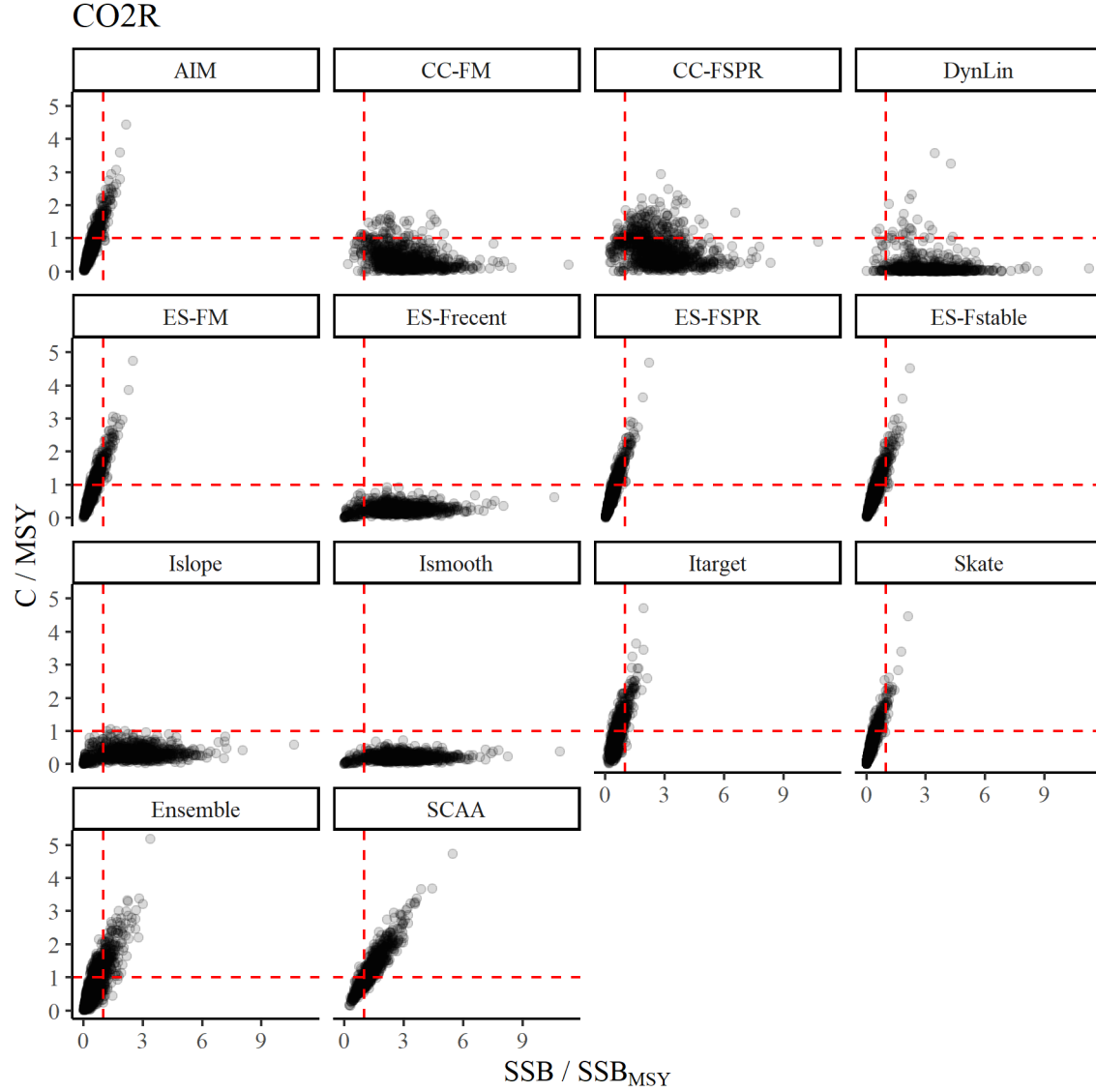


Figure S13. Relationship between long-term average catch and spawning stock biomass relative to their reference points by method. Each point represents the average for years 21-40 in the feedback period for a single iteration of a scenario. The scenario shown is where catch was the source of the retrospective pattern with  $F$  remaining at 2.5 times  $F_{MSY}$  in the second half of the base period, there were two selectivity blocks, and where a buffer was applied to the catch advice (catch multiplier = 0.75).

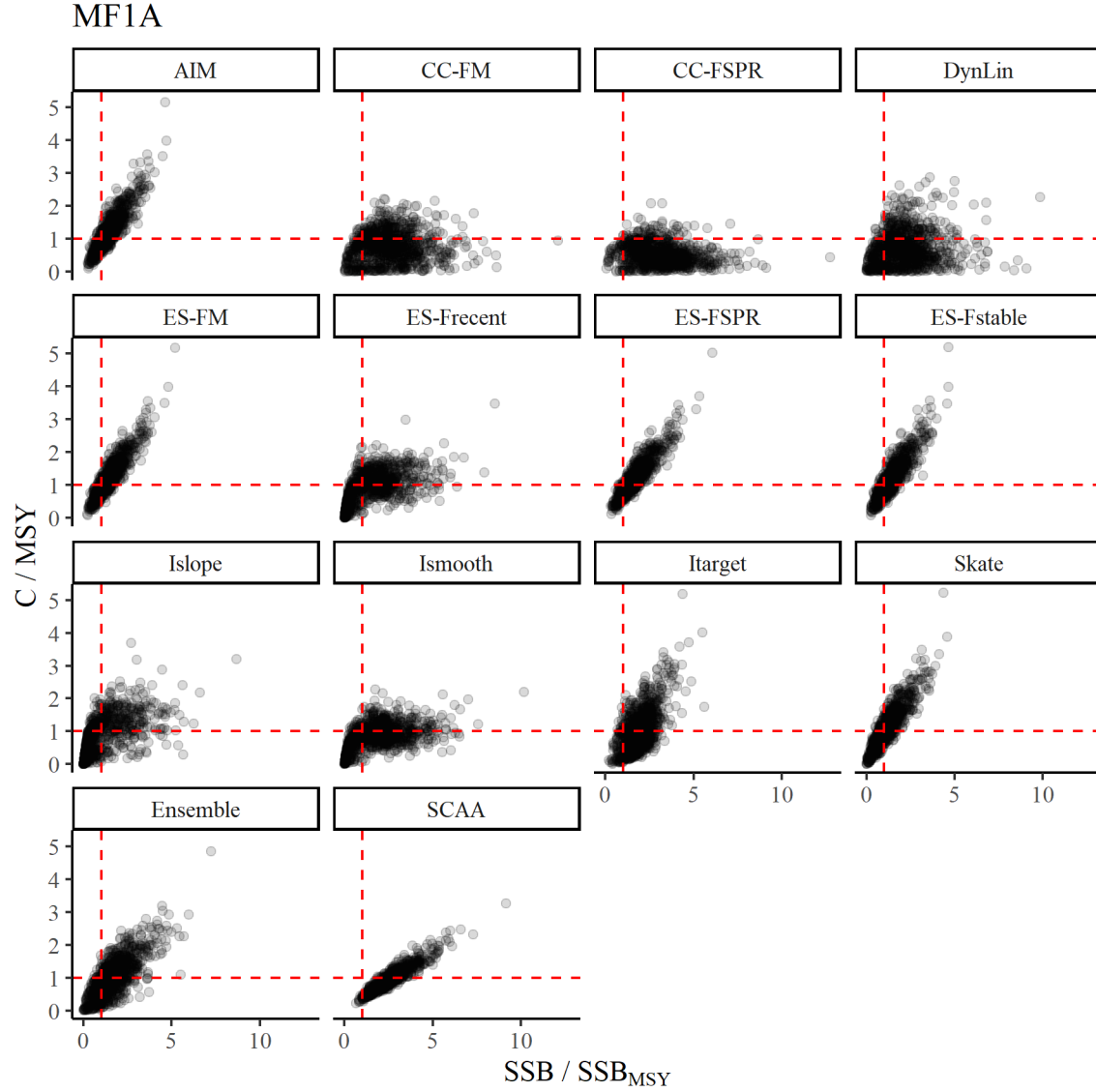


Figure S14. Relationship between long-term average catch and spawning stock biomass relative to their reference points by method. Each point represents the average for years 21-40 in the feedback period for a single iteration of a scenario. The scenario shown is where natural mortality was the source of the retrospective pattern with  $F$  reduced to  $F_{MSY}$  in the second half of the base period, there was a single selectivity block, and where no buffer was applied to the catch advice (catch multiplier = 1).

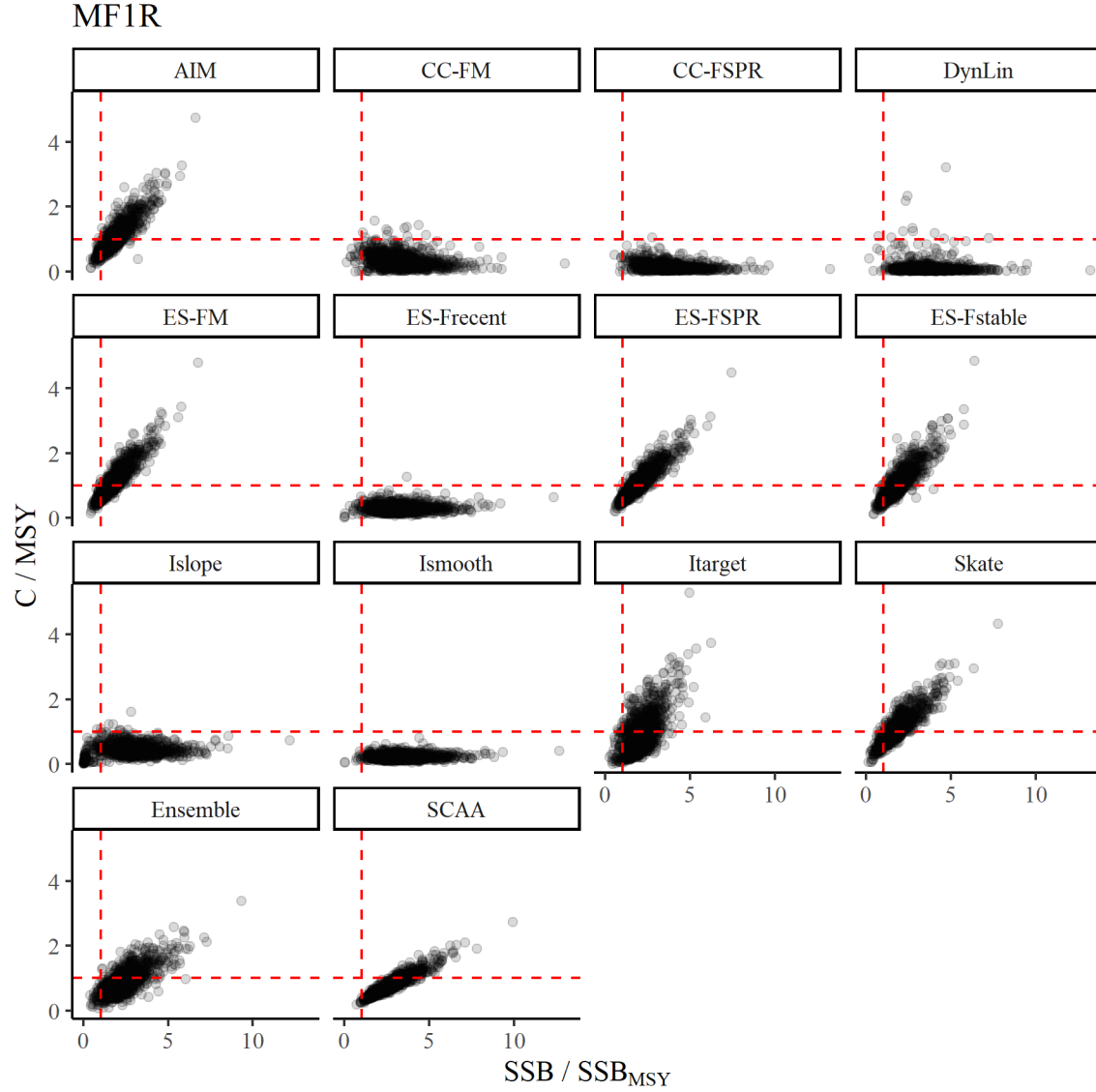


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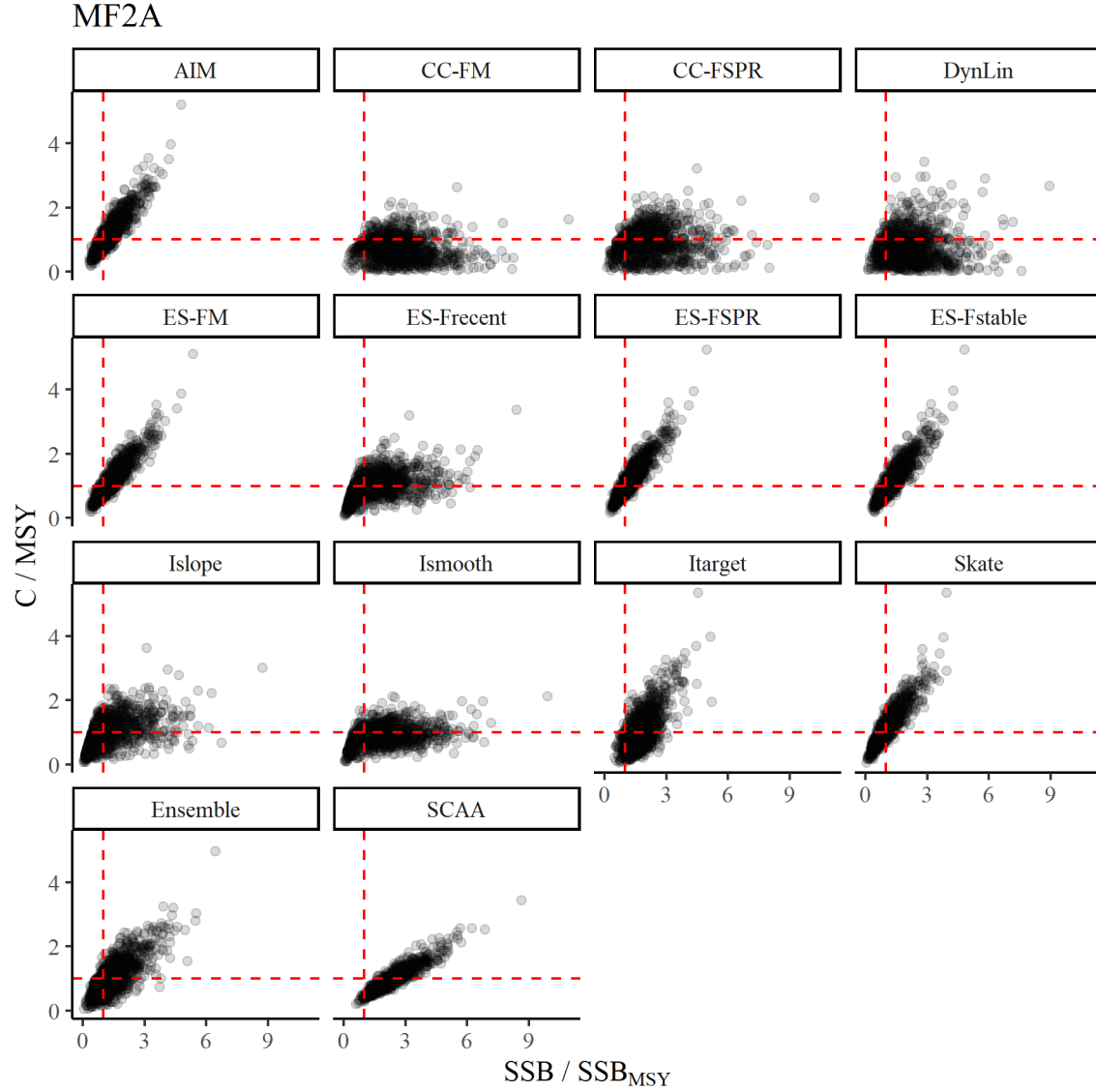


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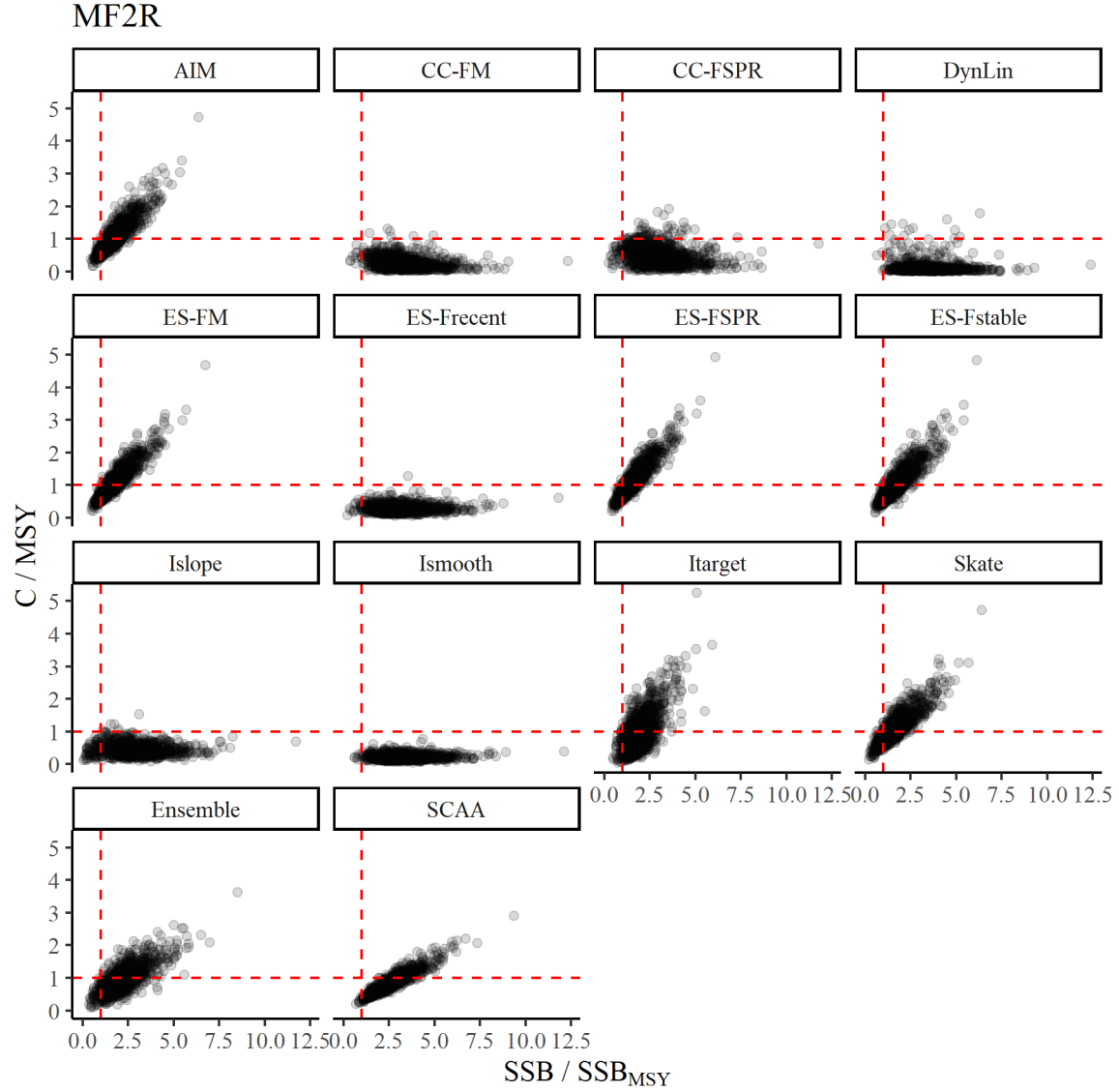


Figure S17. Relationship between long-term average catch and spawning stock biomass relative to their reference points by method. Each point represents the average for years 21-40 in the feedback period for a single iteration of a scenario. The scenario shown is where natural mortality was the source of the retrospective pattern with  $F$  reduced to  $F_{MSY}$  in the second half of the base period, there were two selectivity blocks, and where a buffer was applied to the catch advice (catch multiplier = 0.75).

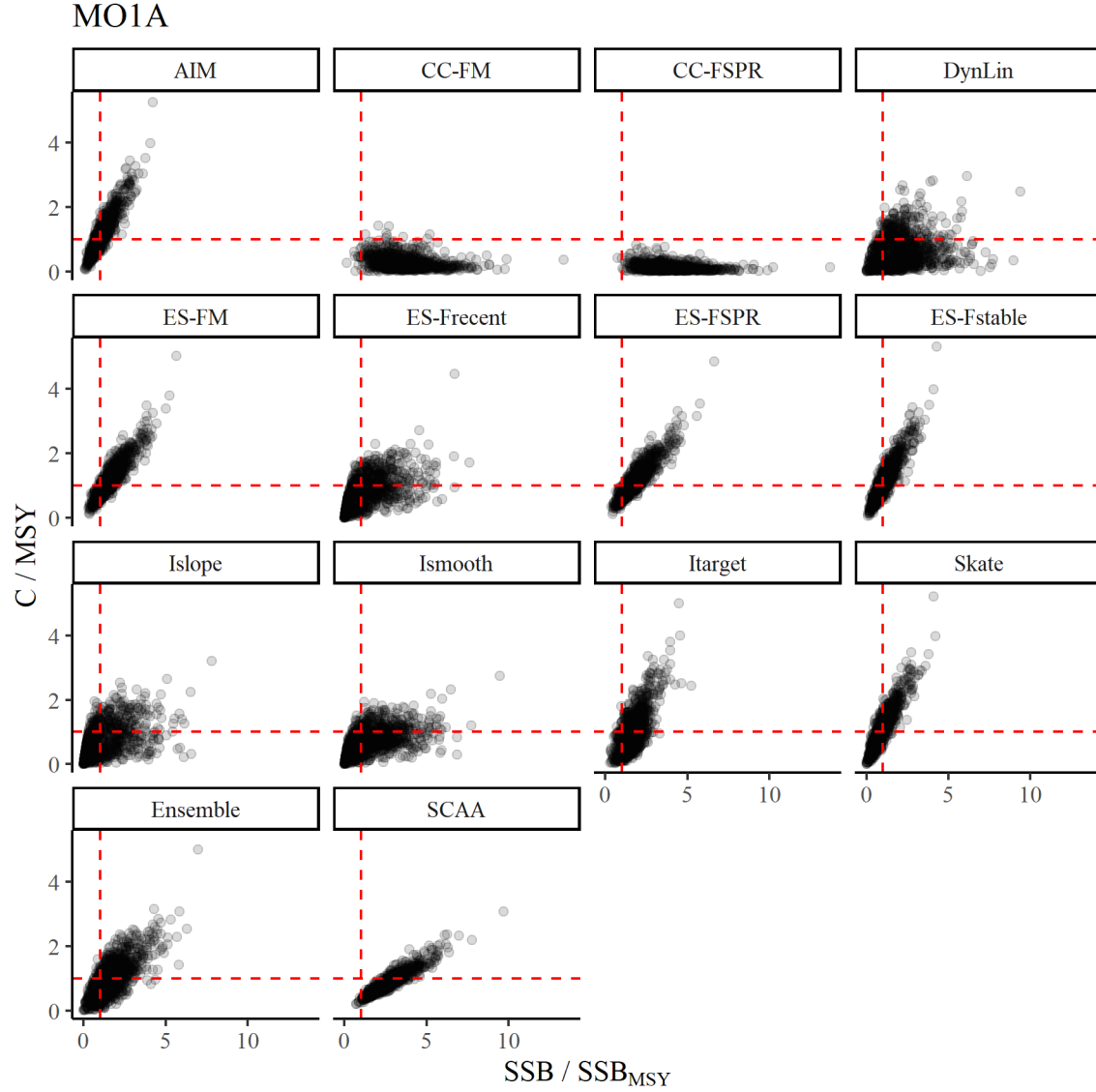


Figure S18. Relationship between long-term average catch and spawning stock biomass relative to their reference points by method. Each point represents the average for years 21-40 in the feedback period for a single iteration of a scenario. The scenario shown is where natural mortality was the source of the retrospective pattern with  $F$  remaining at 2.5 times  $F_{MSY}$  in the second half of the base period, there was a single selectivity block, and where no buffer was applied to the catch advice (catch multiplier = 1).

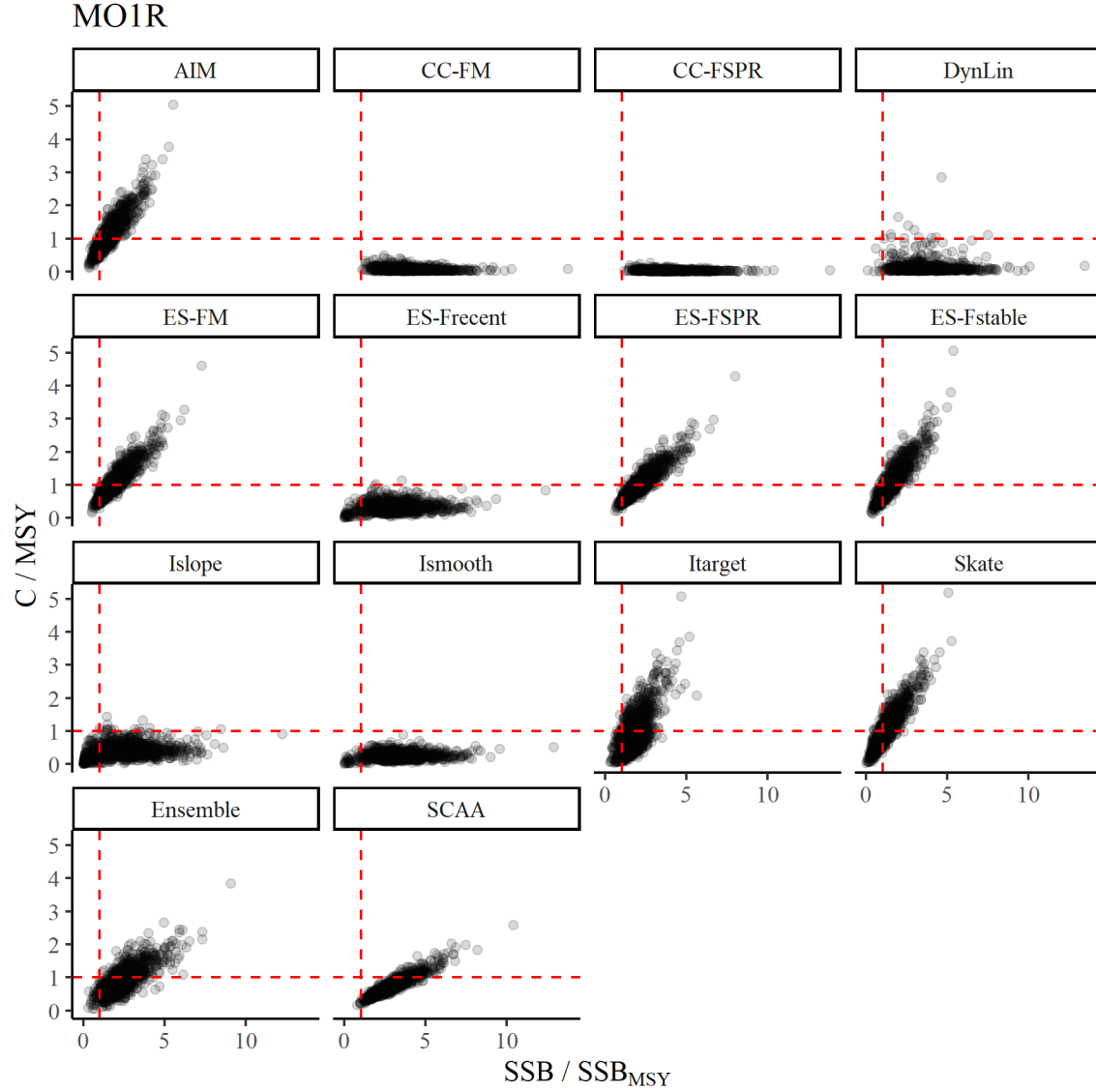


Figure S19. Relationship between long-term average catch and spawning stock biomass relative to their reference points by method. Each point represents the average for years 21-40 in the feedback period for a single iteration of a scenario. The scenario shown is where natural mortality was the source of the retrospective pattern with  $F$  remaining at 2.5 times  $F_{MSY}$  in the second half of the base period, there was a single selectivity block, and where a buffer was applied to the catch advice (catch multiplier = 0.75).



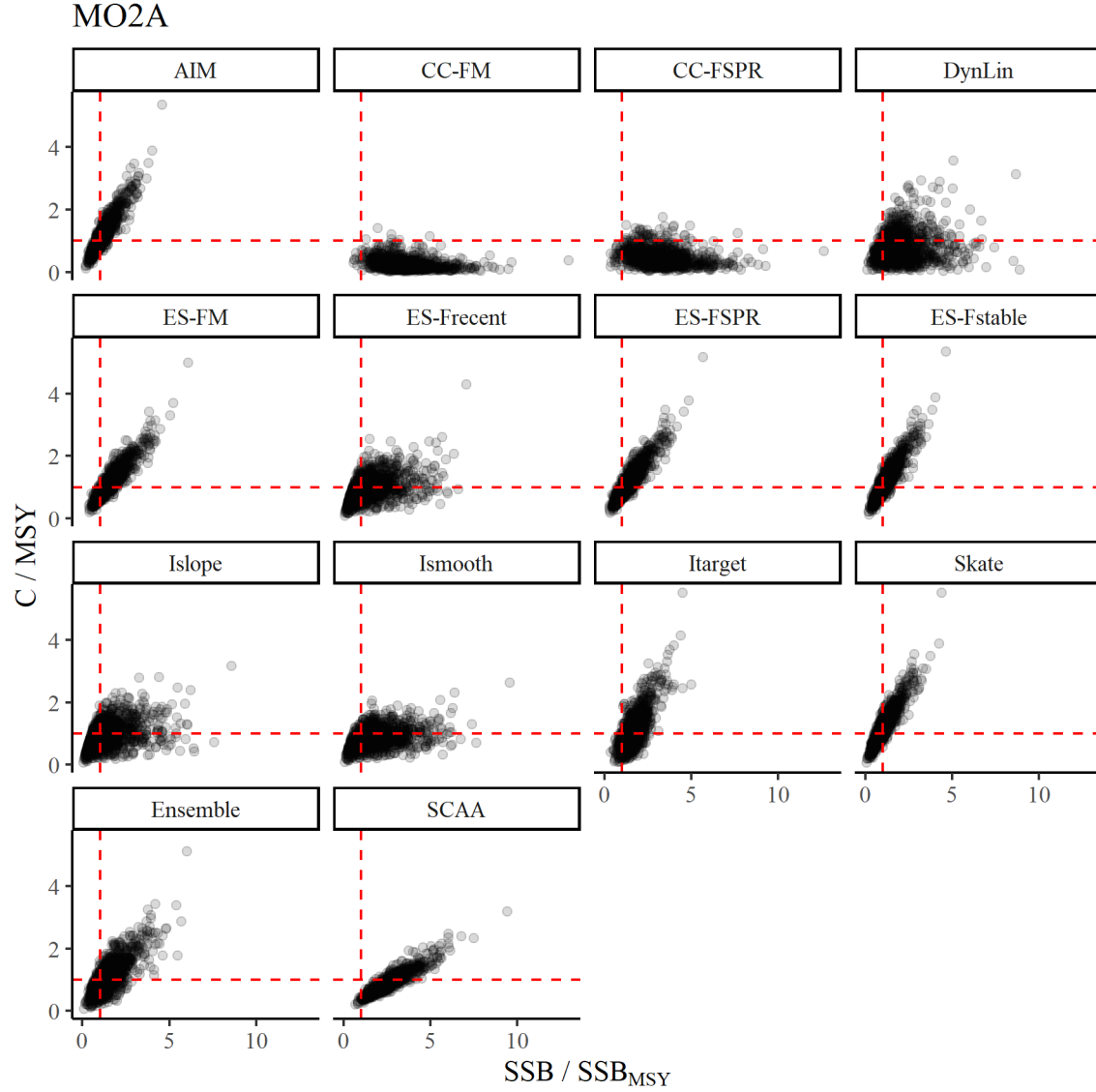


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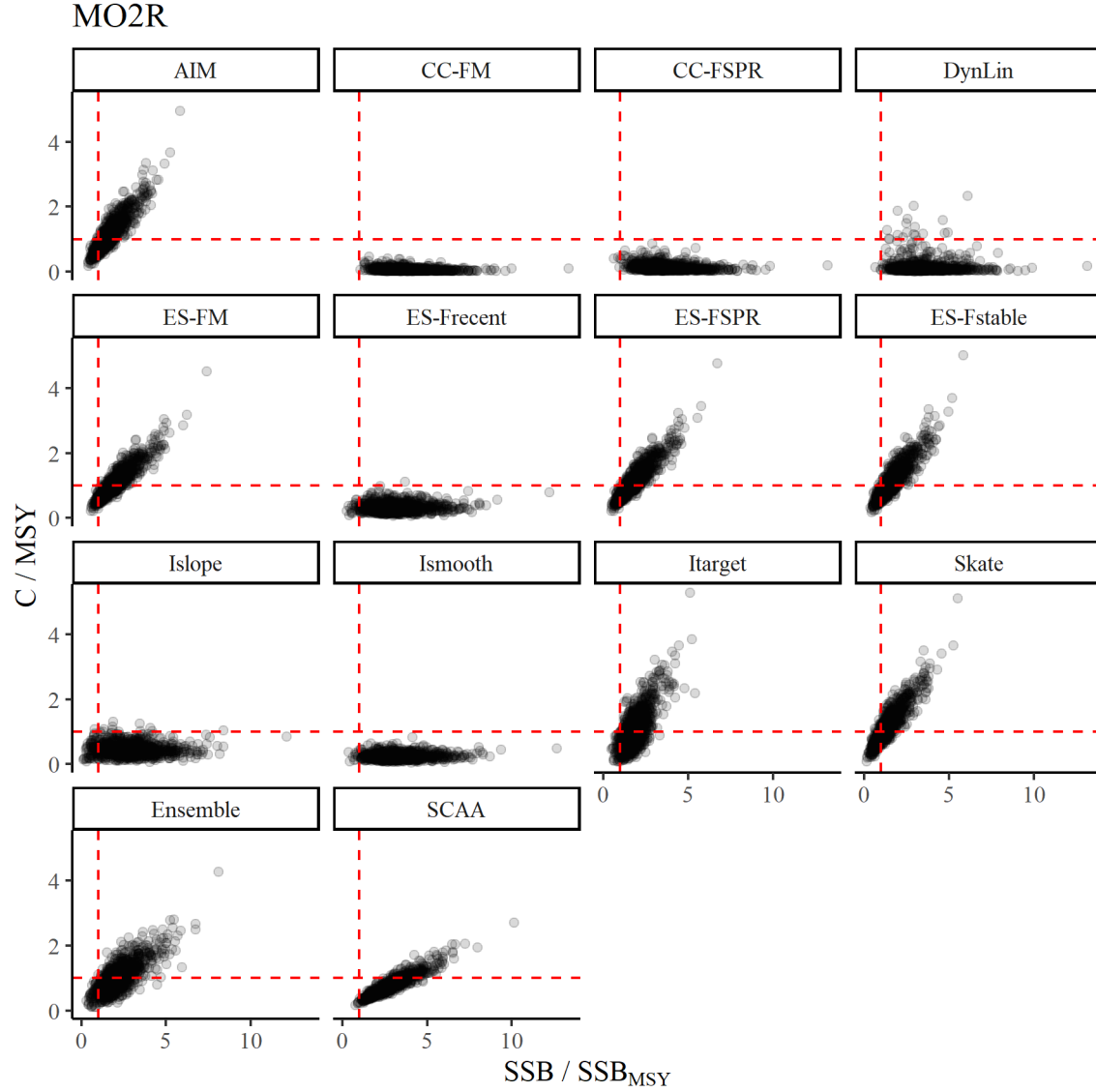


Figure S21. Relationship between long-term average catch and spawning stock biomass relative to their reference points by method. Each point represents the average for years 21-40 in the feedback period for a single iteration of a scenario. The scenario shown is where natural mortality was the source of the retrospective pattern with  $F$  remaining at 2.5 times  $F_{MSY}$  in the second half of the base period, there were two selectivity blocks, and where a buffer was applied to the catch advice (catch multiplier = 0.75).

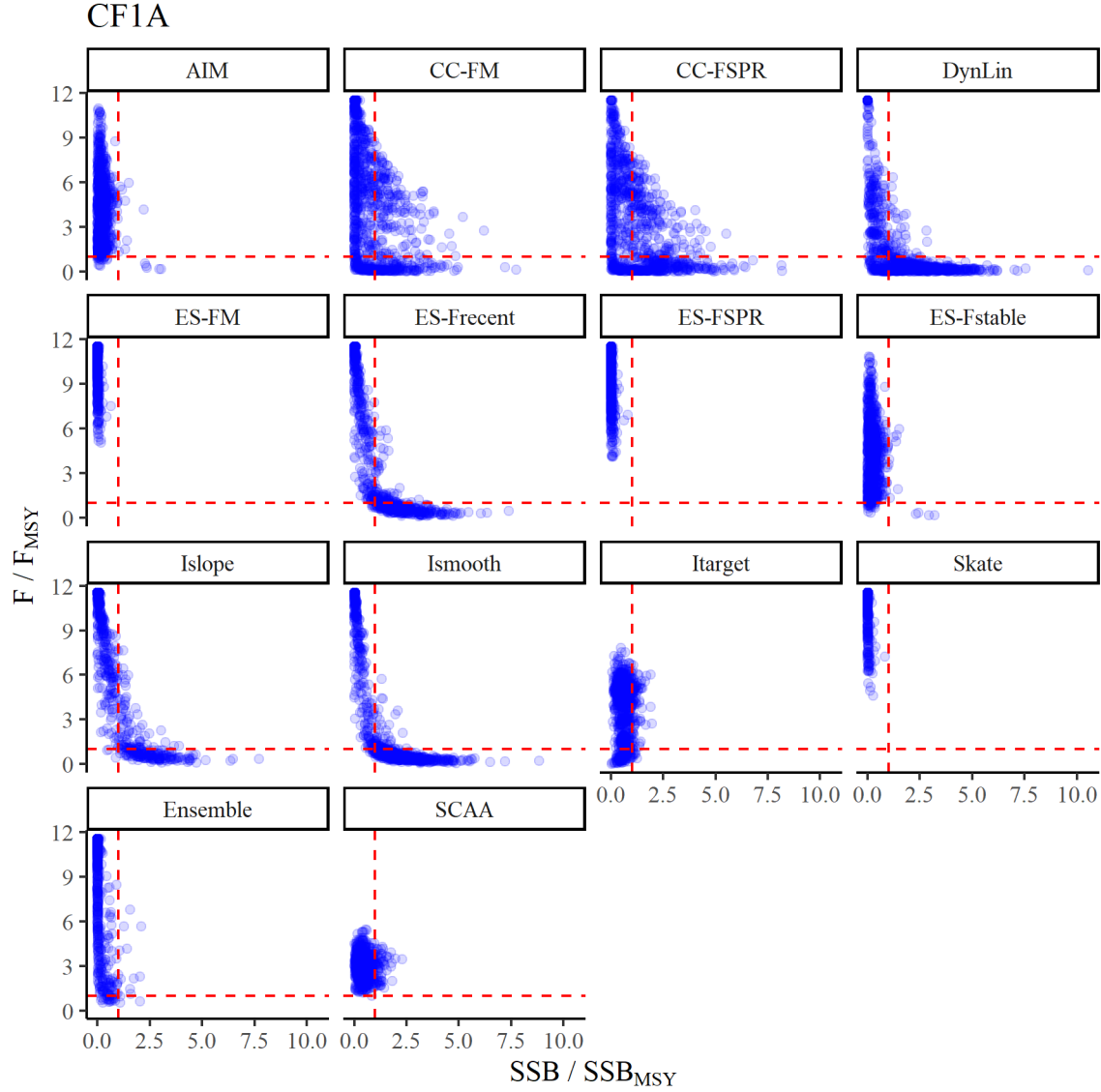


Figure S22. Relationship between long-term average fishing mortality rate and spawning stock biomass relative to their reference points by method. Each point represents the average for years 21-40 in the feedback period for a single iteration of a scenario. The scenario shown is where catch was the source of the retrospective pattern with  $F$  reduced to  $F_{MSY}$  in the second half of the base period, there was a single selectivity block, and where no buffer was applied to the catch advice (catch multiplier = 1).

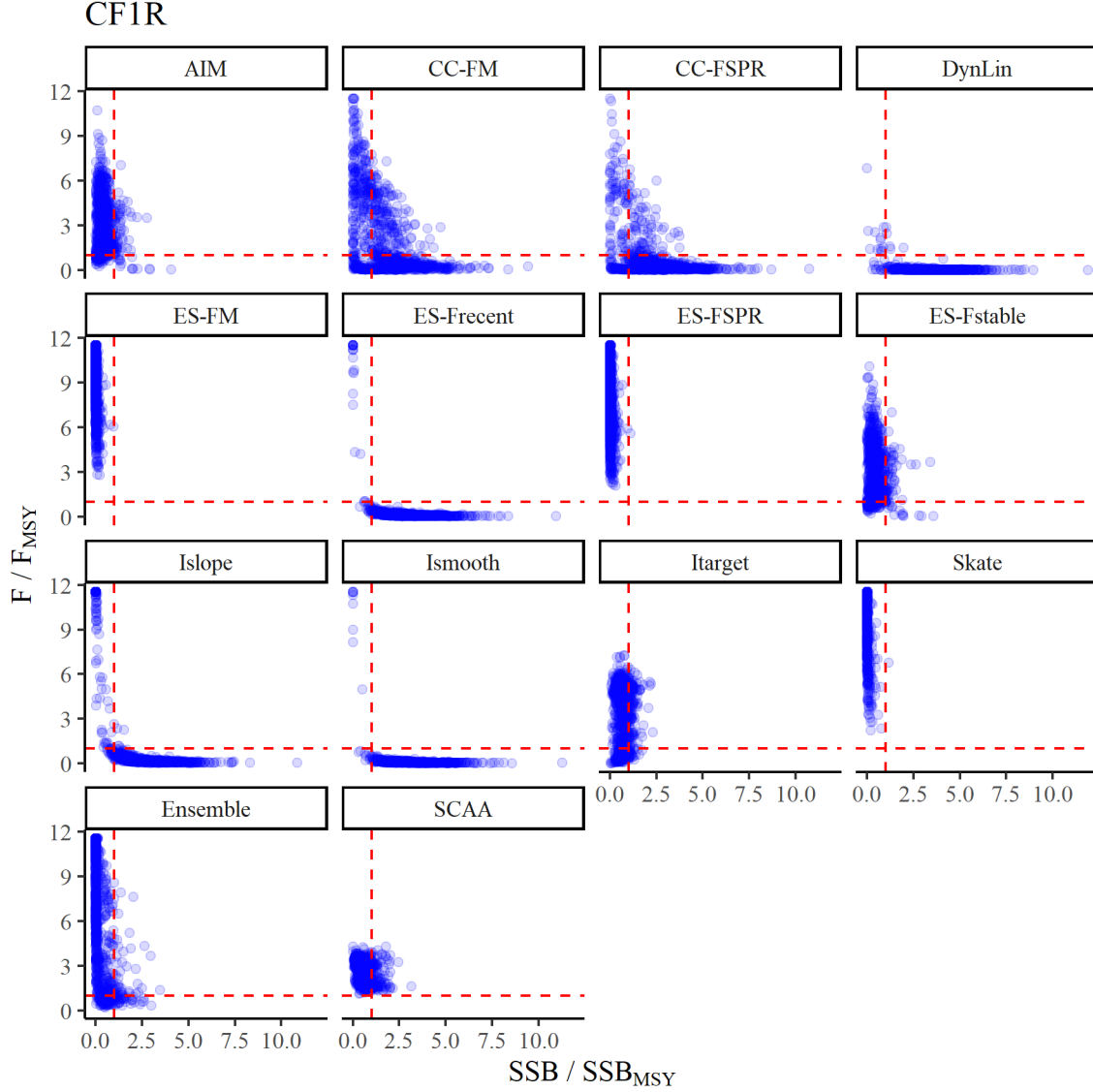


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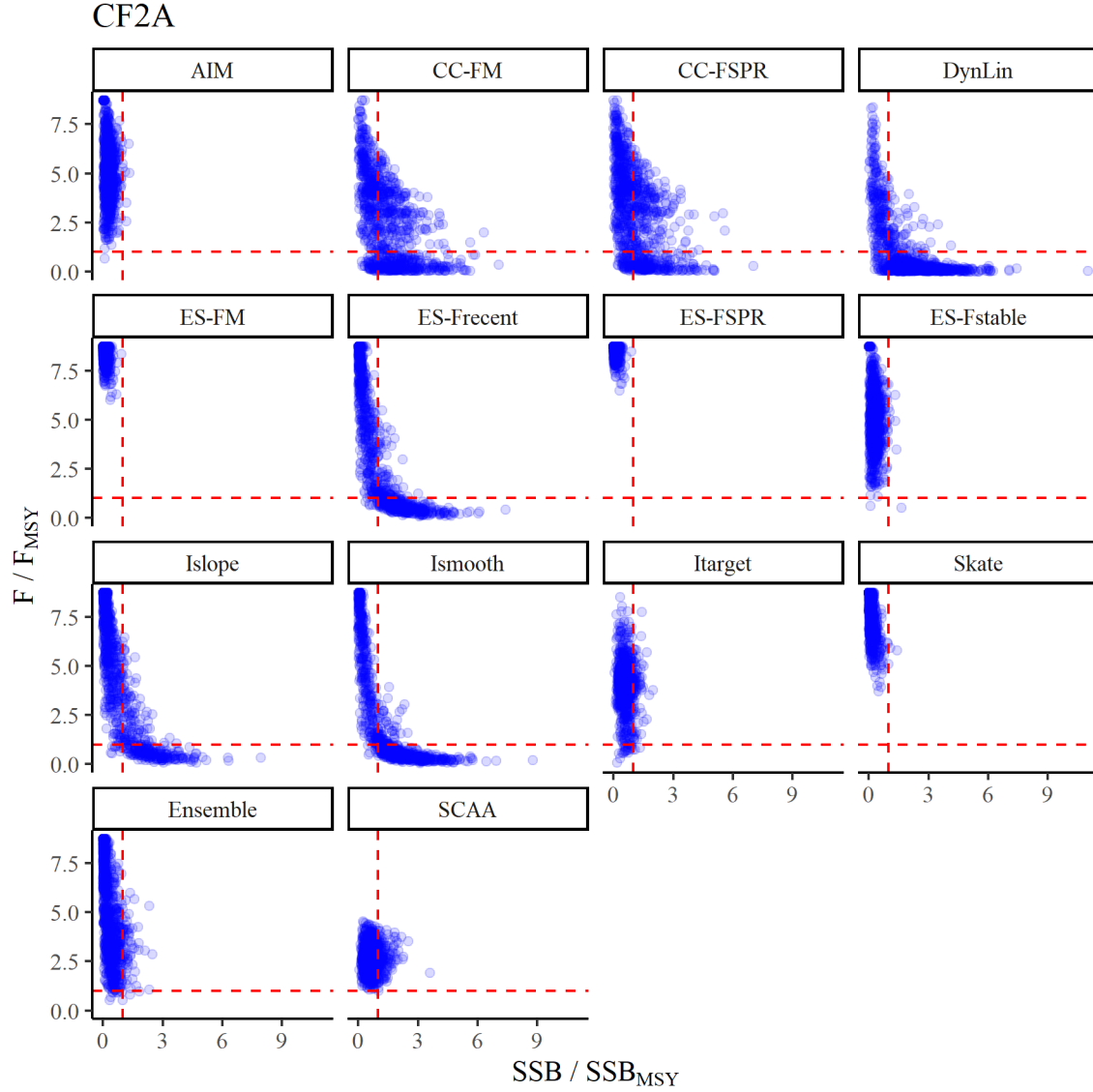


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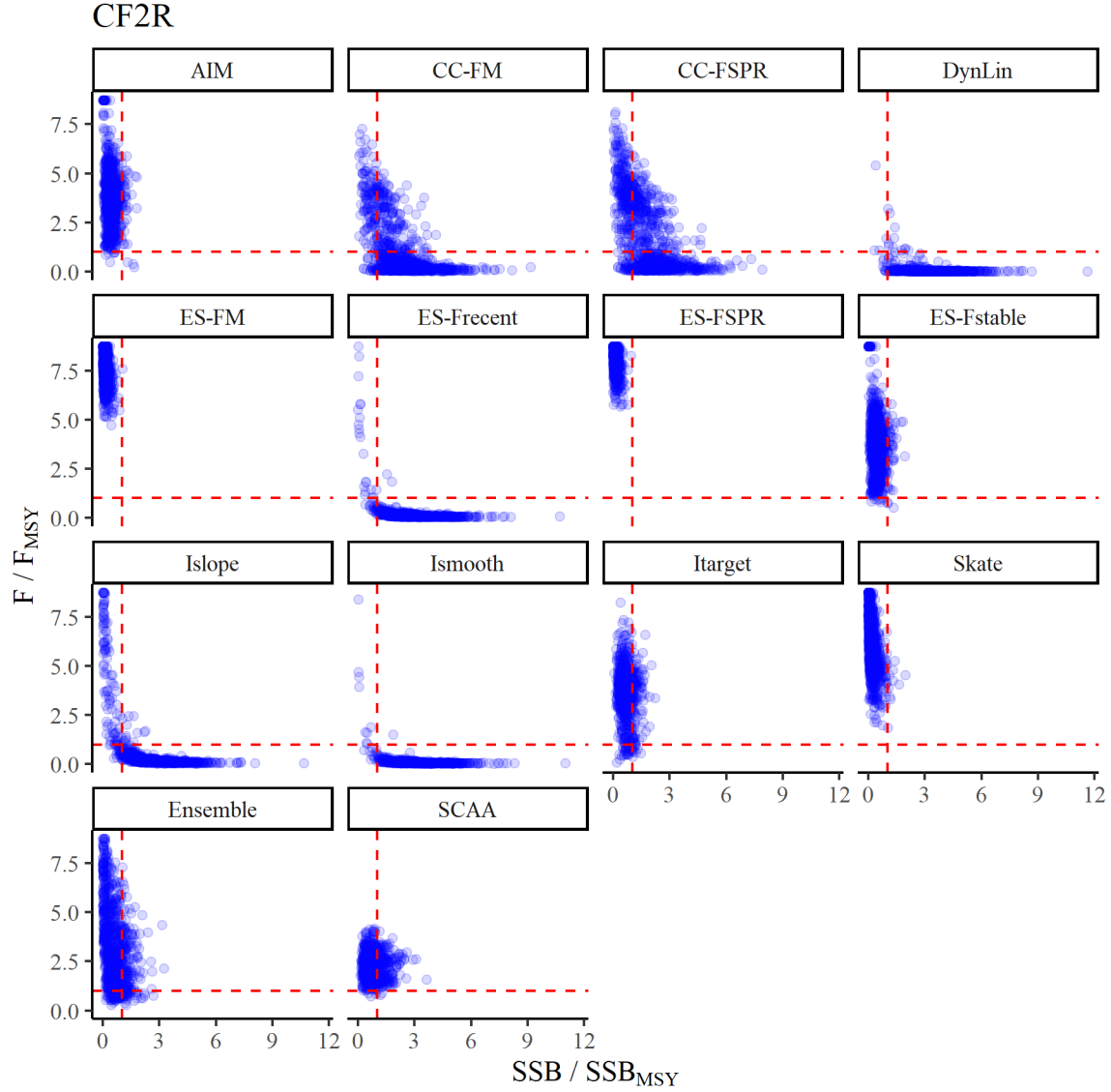


Figure S25. Relationship between long-term average fishing mortality rate and spawning stock biomass relative to their reference points by method. Each point represents the average for years 21-40 in the feedback period for a single iteration of a scenario. The scenario shown is where catch was the source of the retrospective pattern with  $F$  reduced to  $F_{MSY}$  in the second half of the base period, there were two selectivity blocks, and where a buffer was applied to the catch advice (catch multiplier = 0.75).

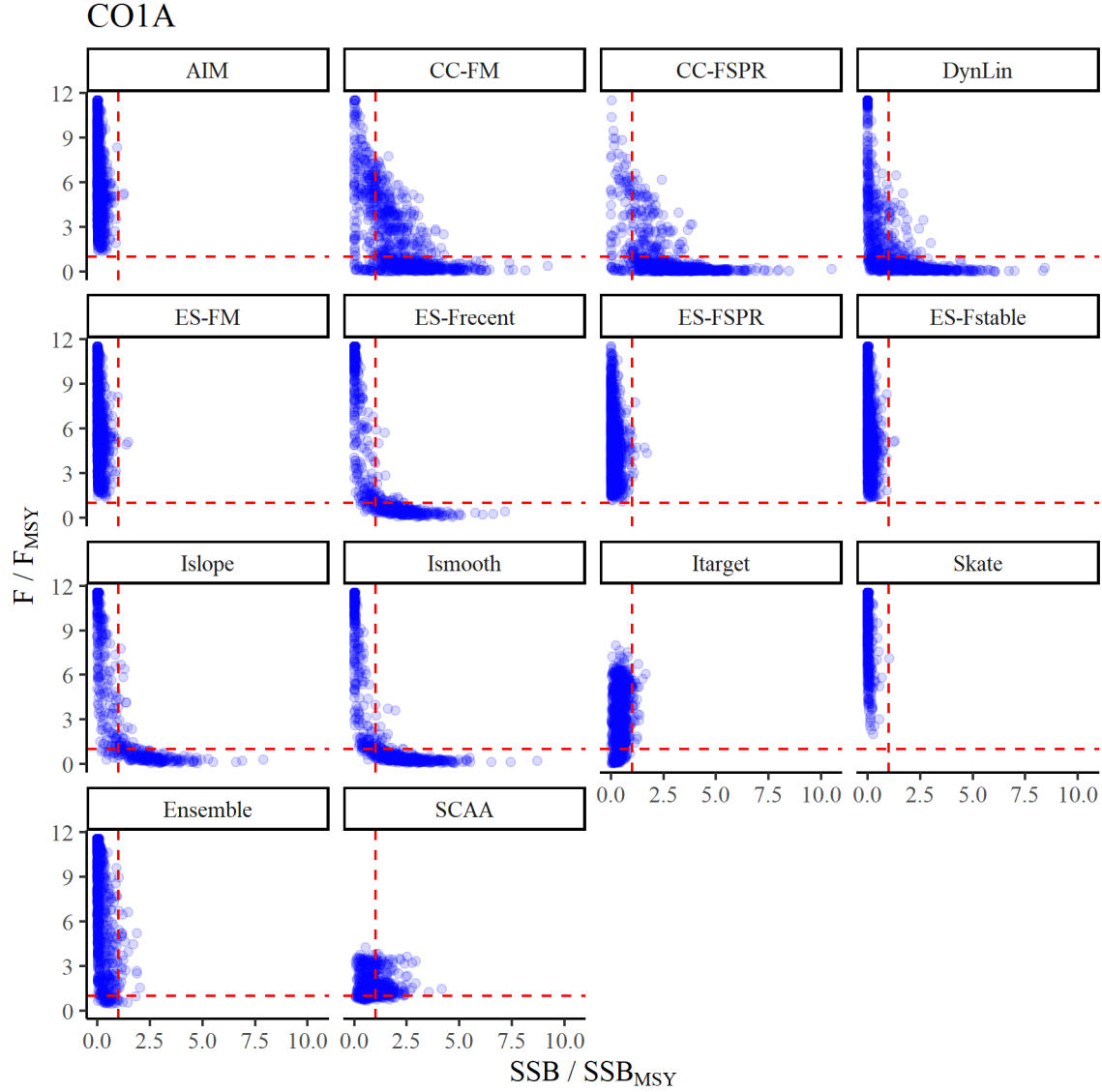


Figure S26. Relationship between long-term average fishing mortality rate and spawning stock biomass relative to their reference points by method. Each point represents the average for years 21-40 in the feedback period for a single iteration of a scenario. The scenario shown is where catch was the source of the retrospective pattern with  $F$  remaining at 2.5 times  $F_{MSY}$  in the second half of the base period, there was a single selectivity block, and where no buffer was applied to the catch advice (catch multiplier = 1).

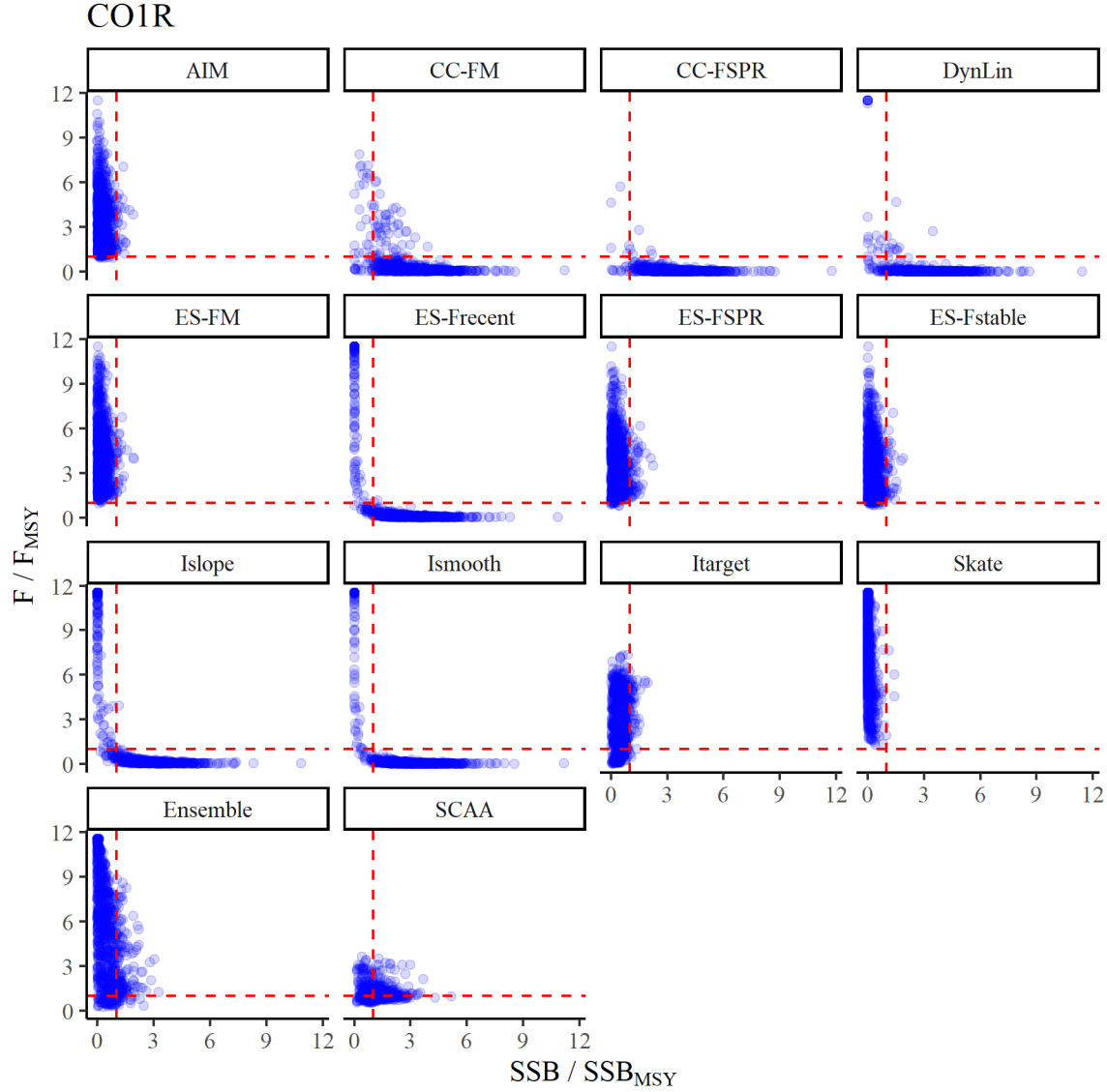


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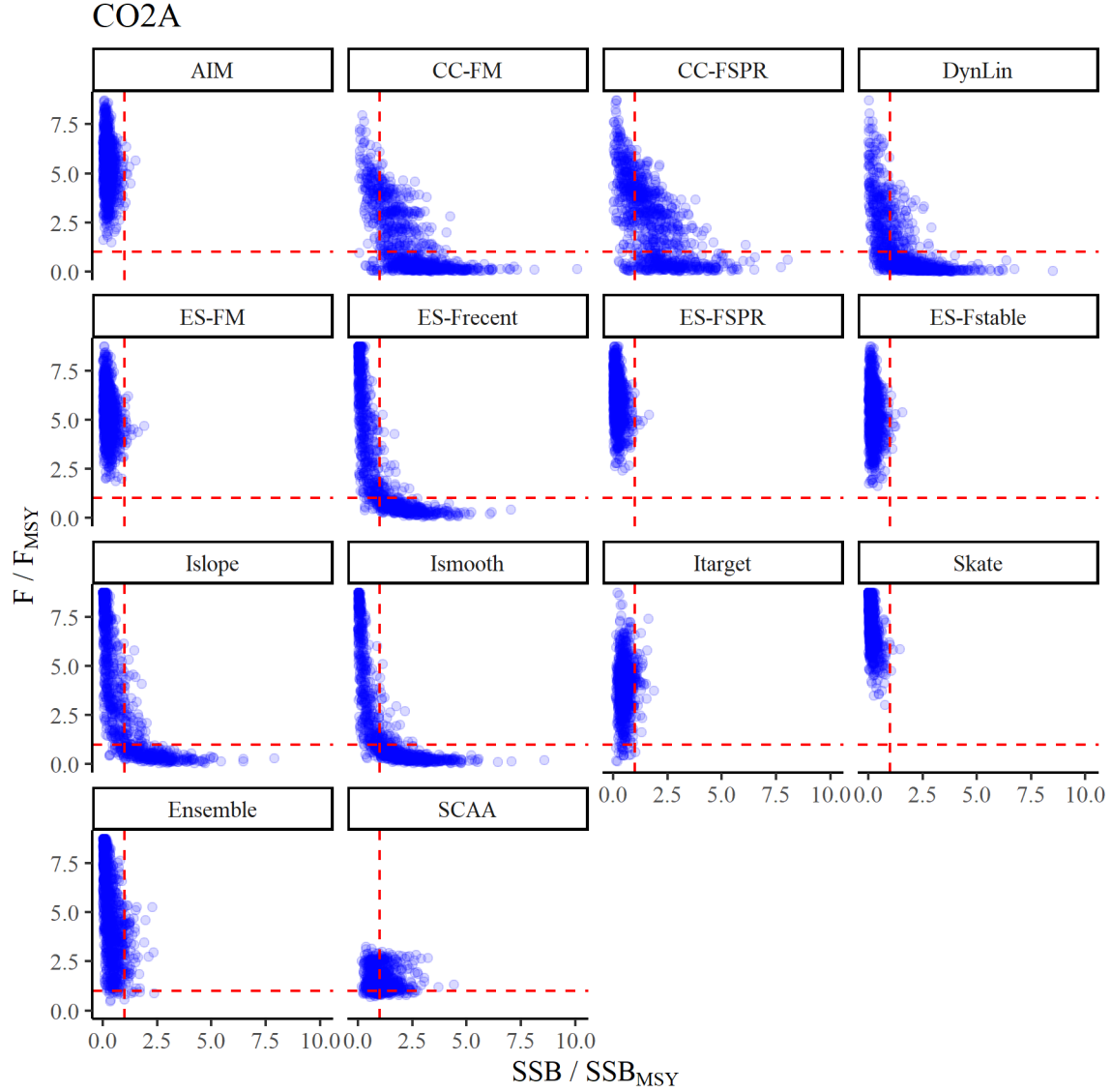


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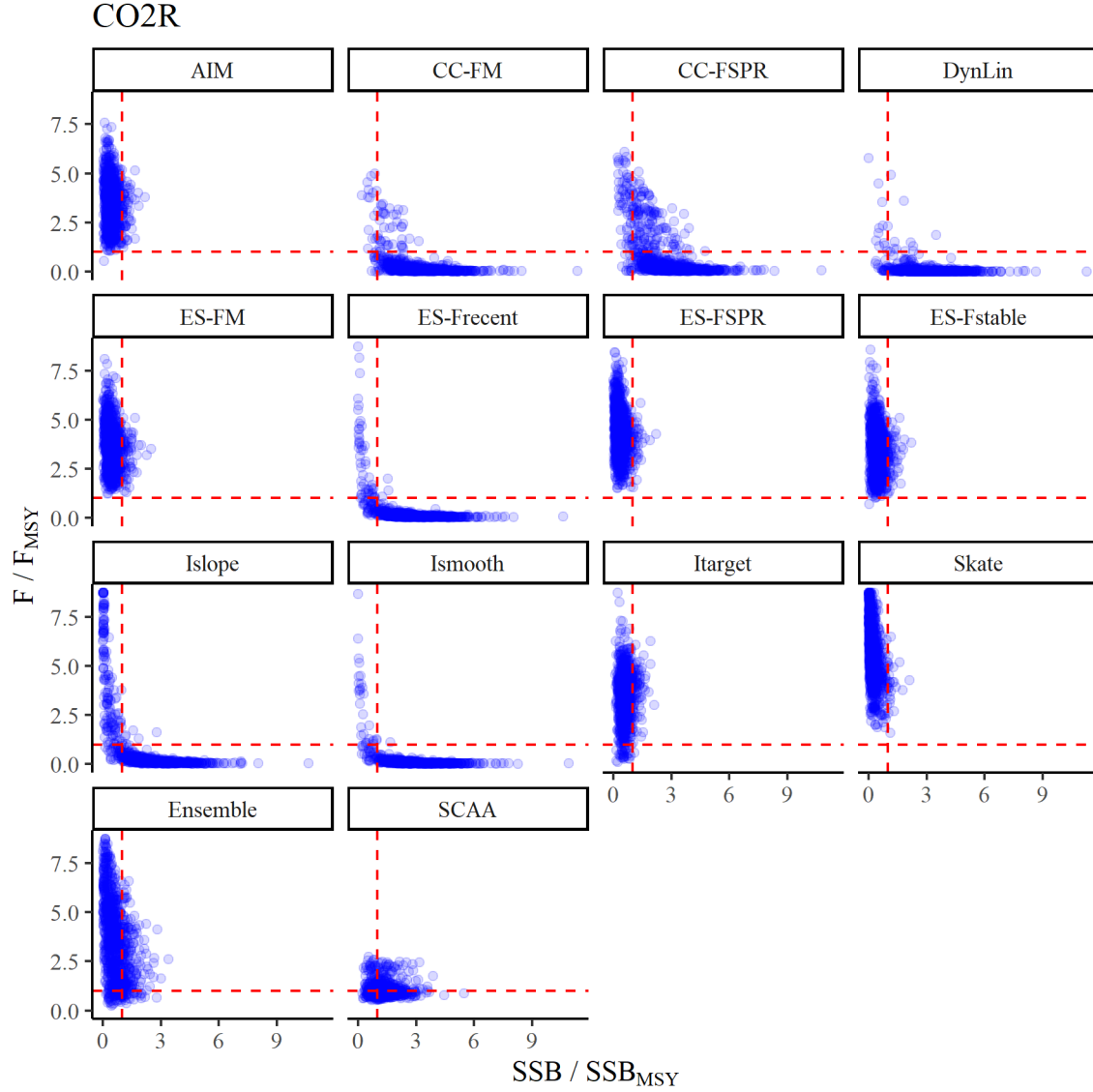


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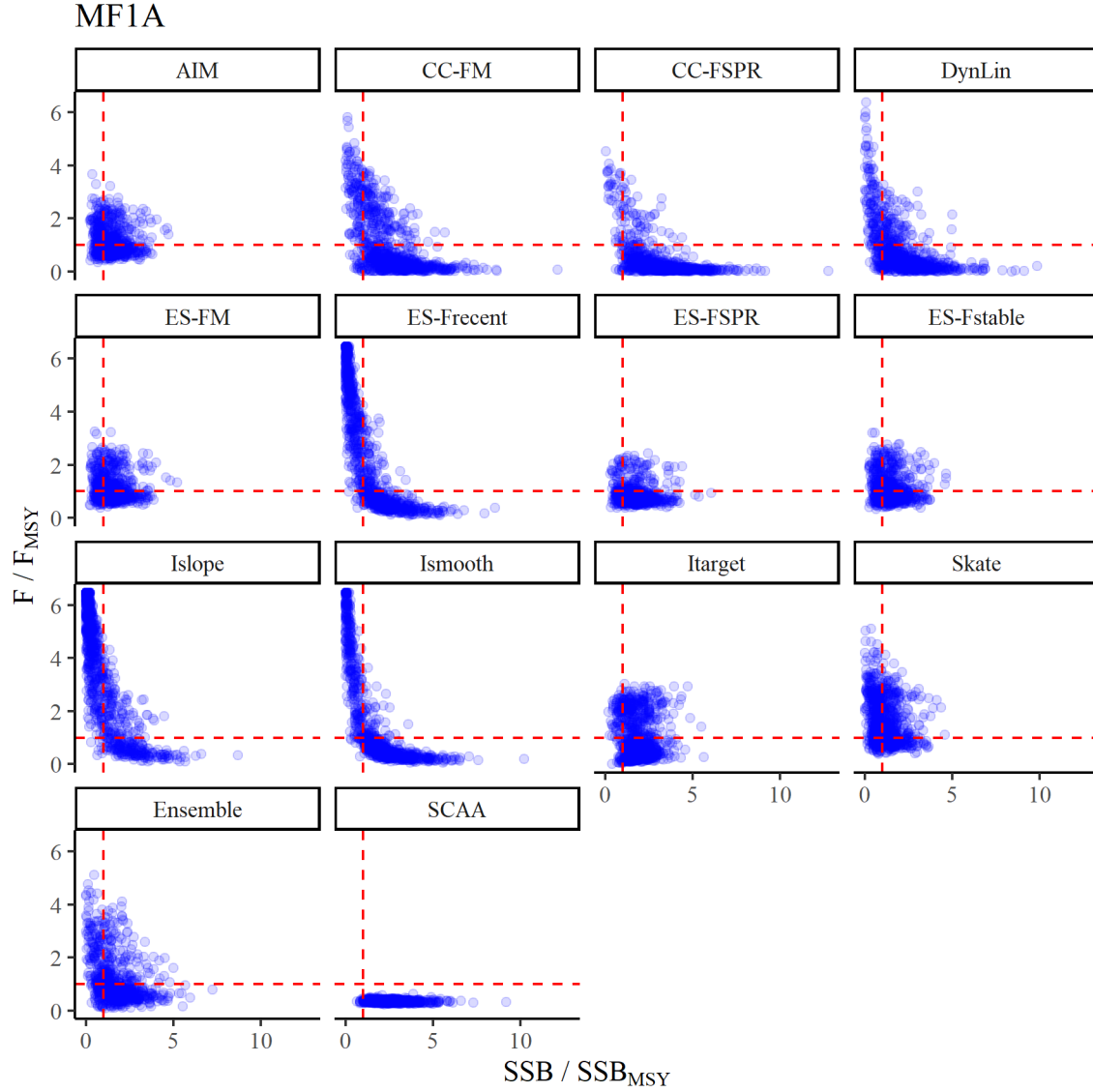


Figure S30. Relationship between long-term average fishing mortality rate and spawning stock biomass relative to their reference points by method. Each point represents the average for years 21-40 in the feedback period for a single iteration of a scenario. The scenario shown is where natural mortality was the source of the retrospective pattern with  $F$  reduced to  $F_{MSY}$  in the second half of the base period, there was a single selectivity block, and where no buffer was applied to the catch advice (catch multiplier = 1).

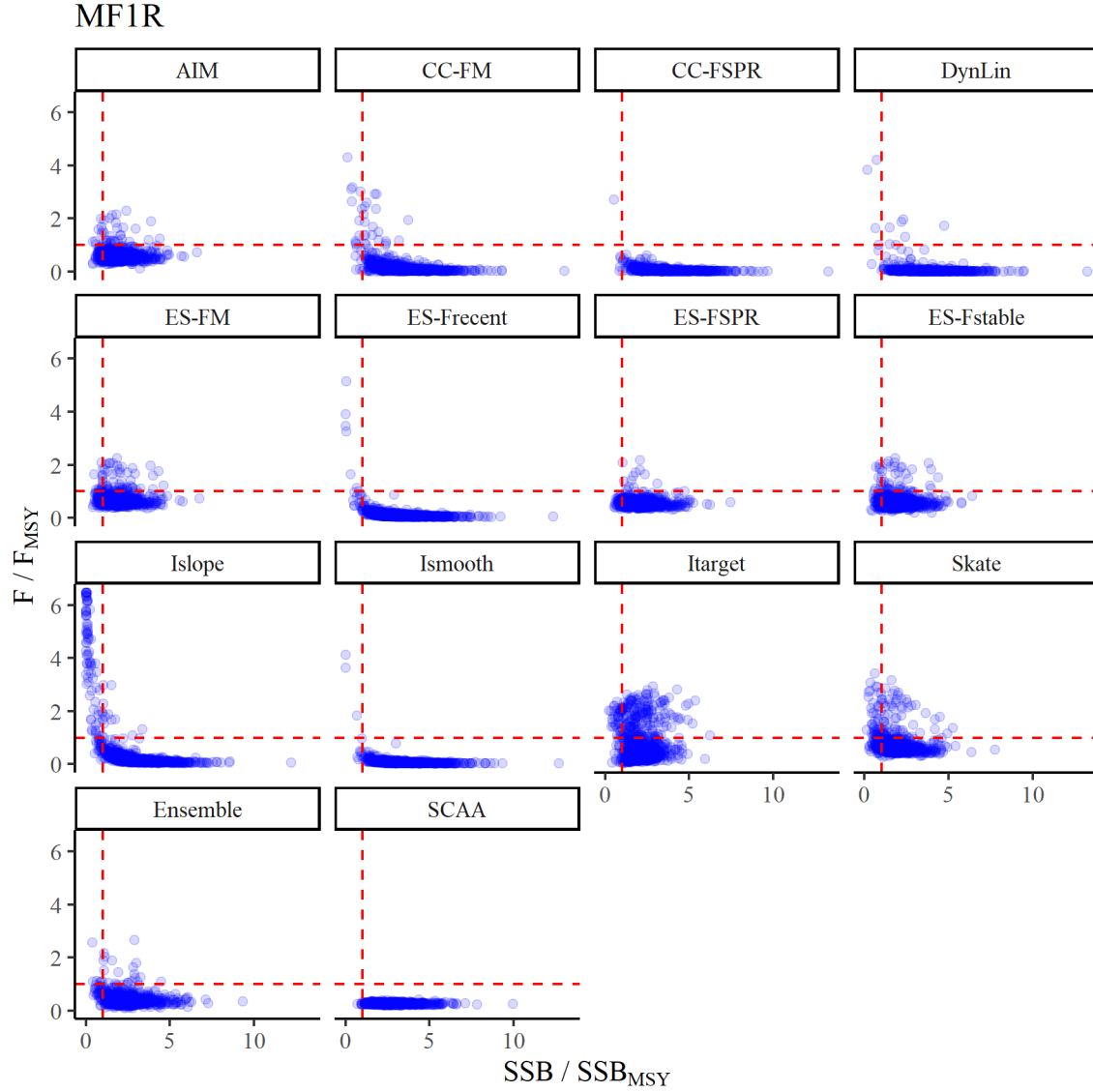


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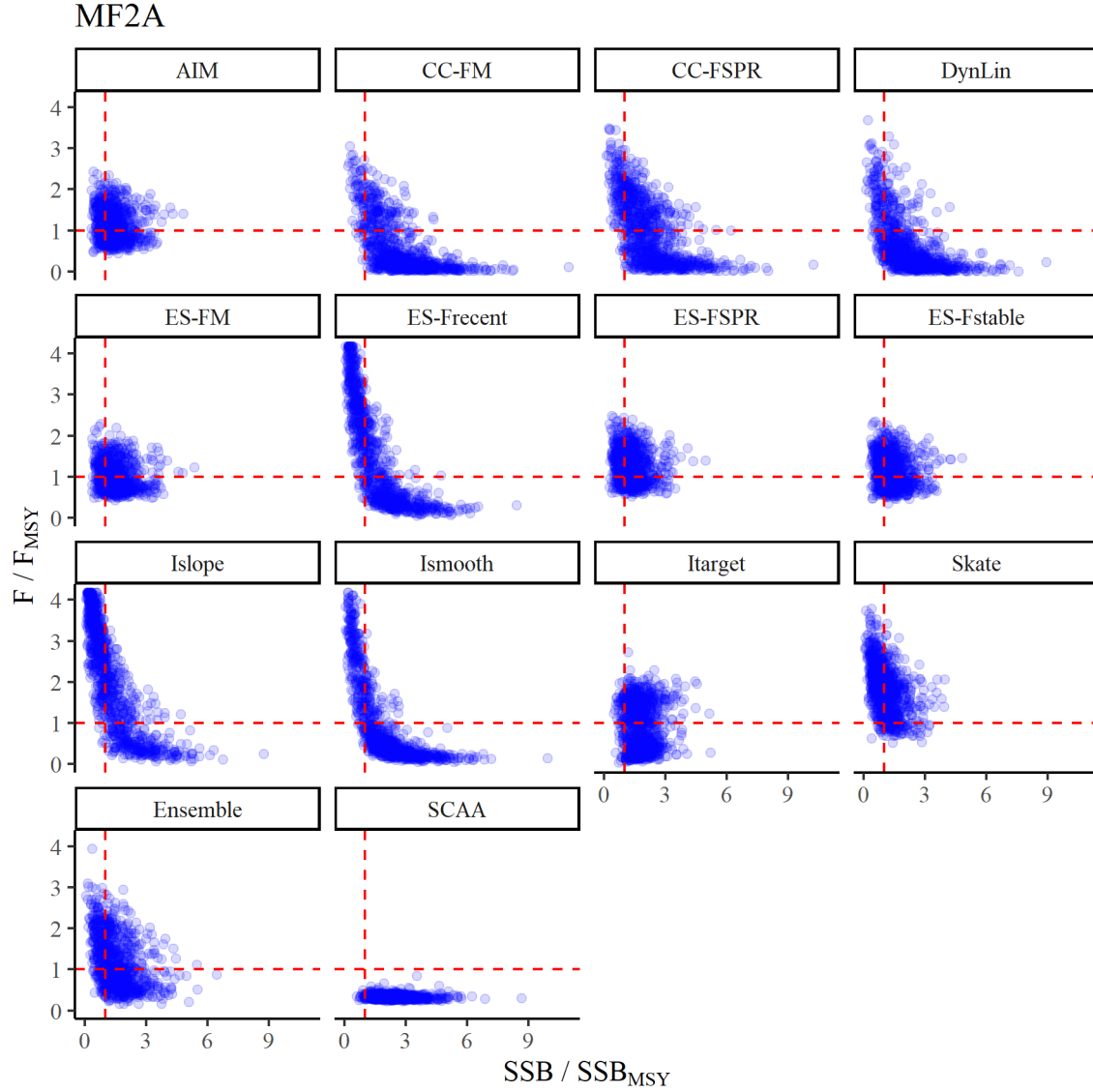


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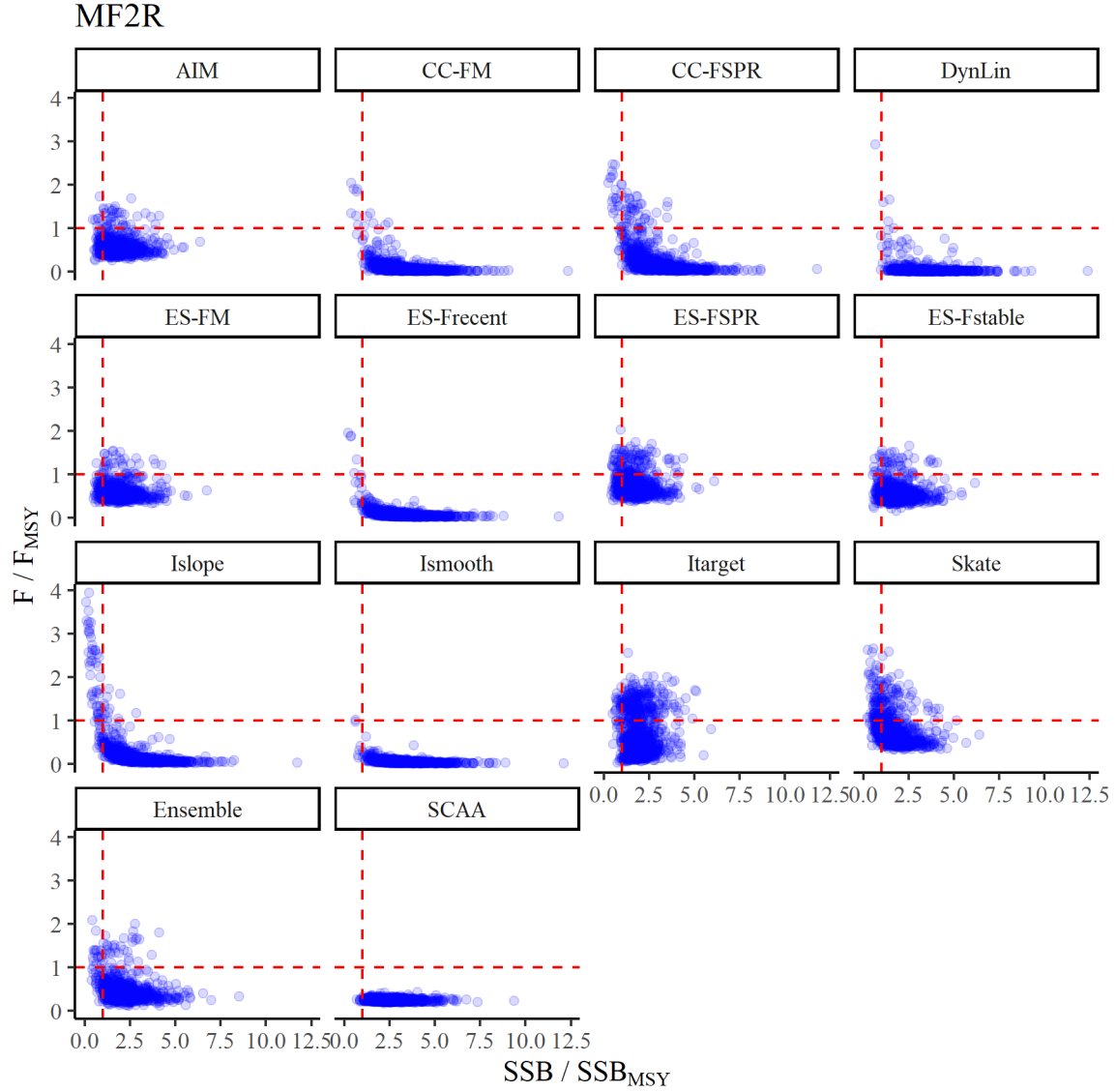


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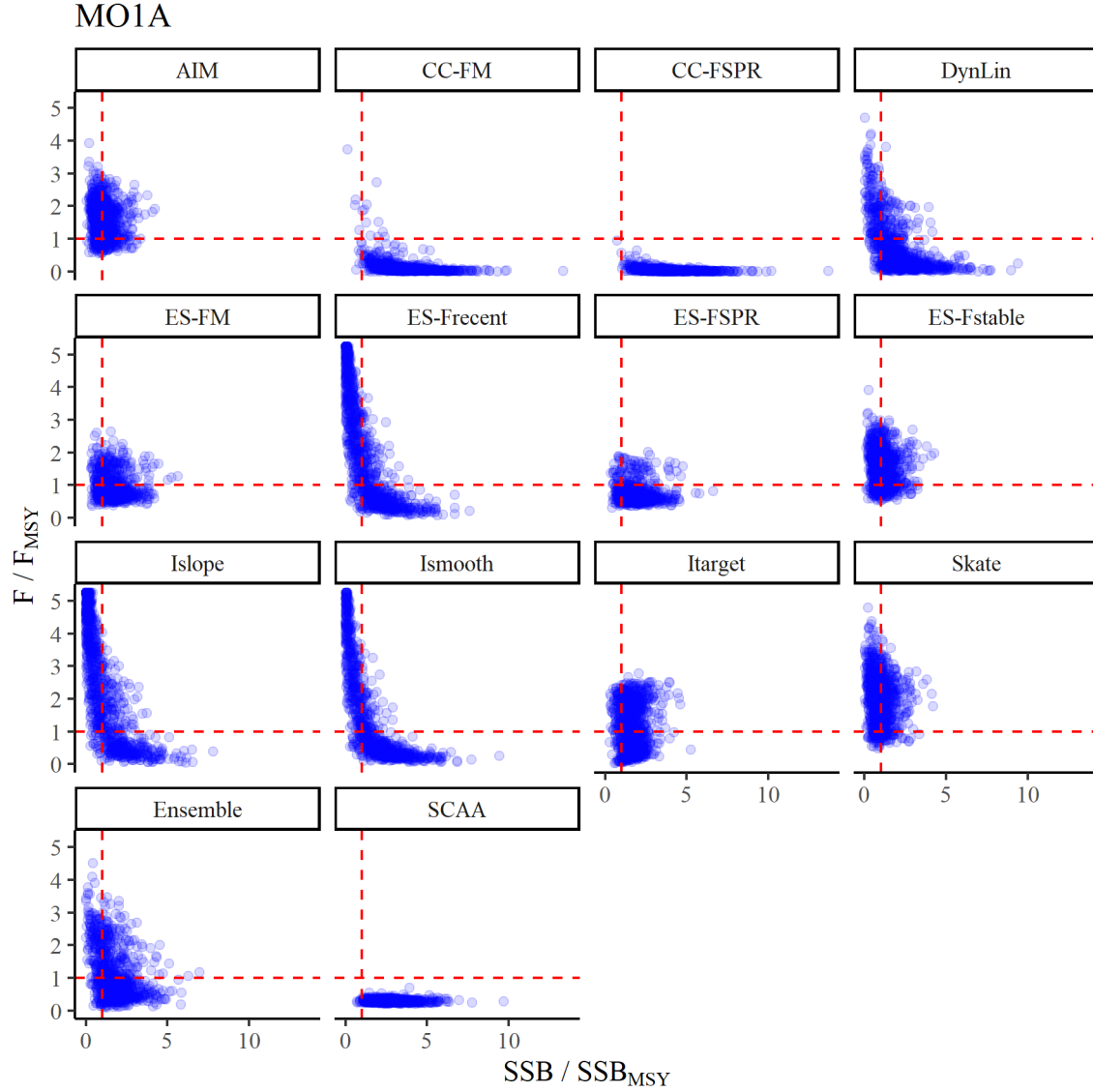


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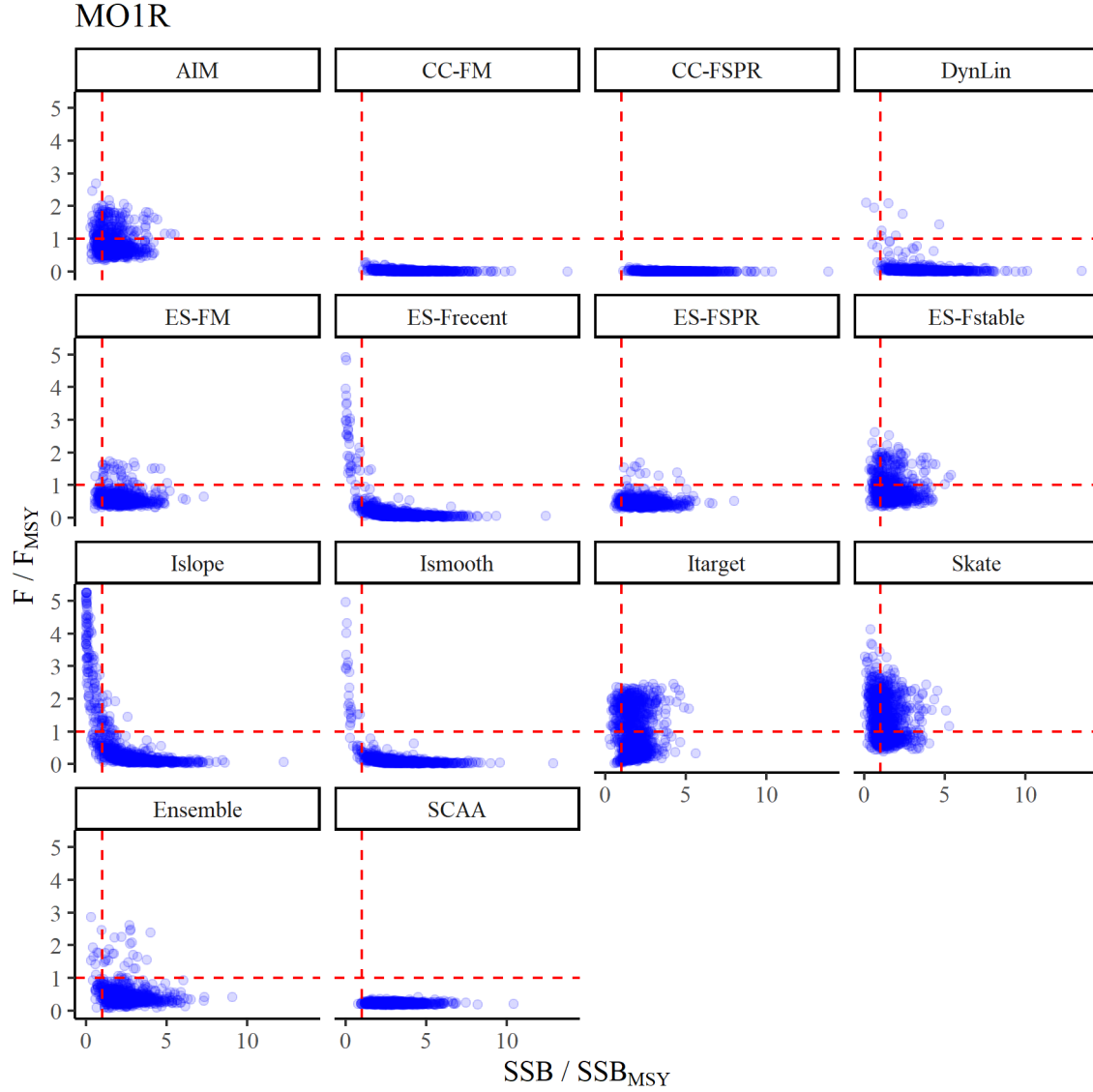


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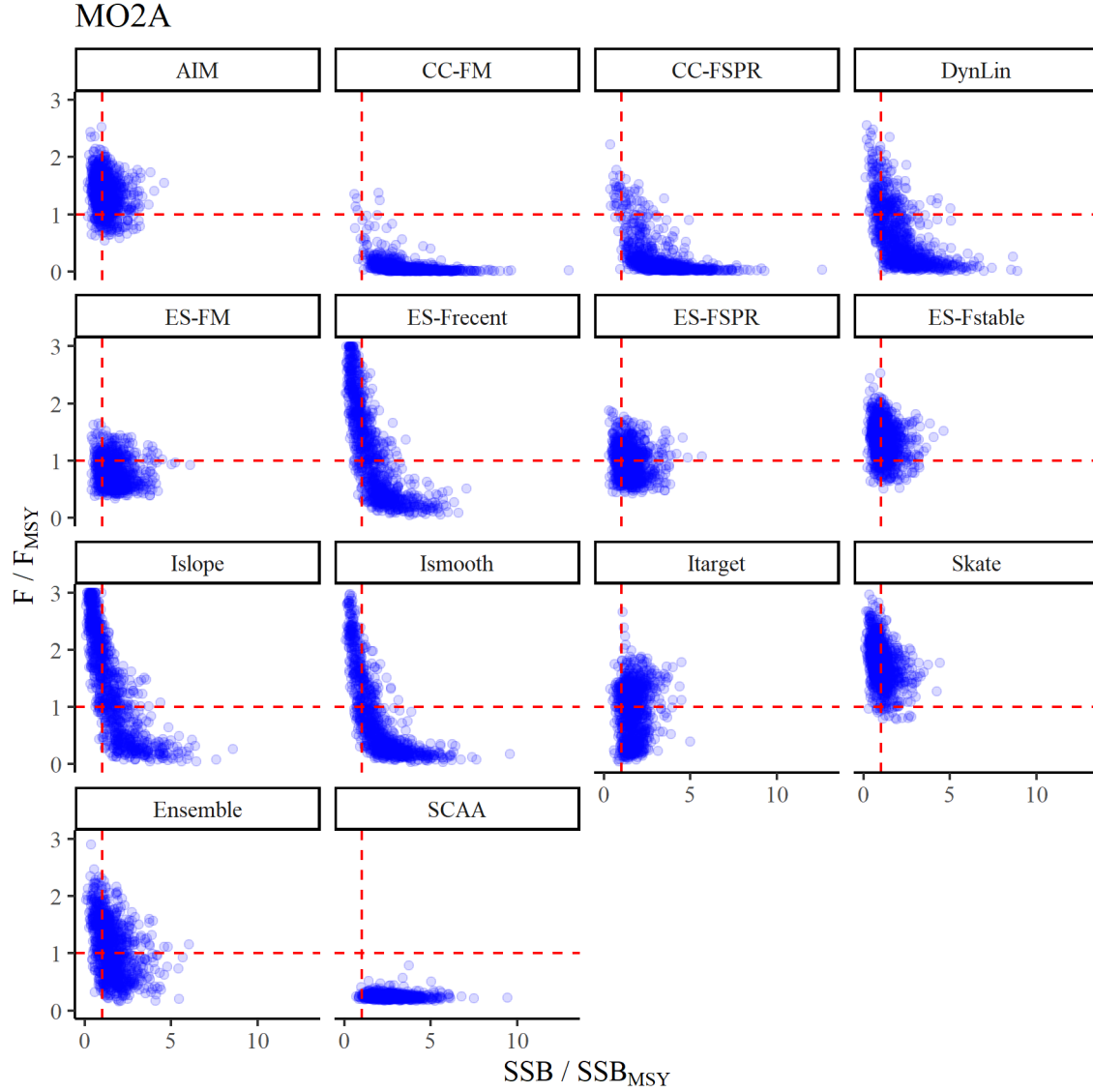


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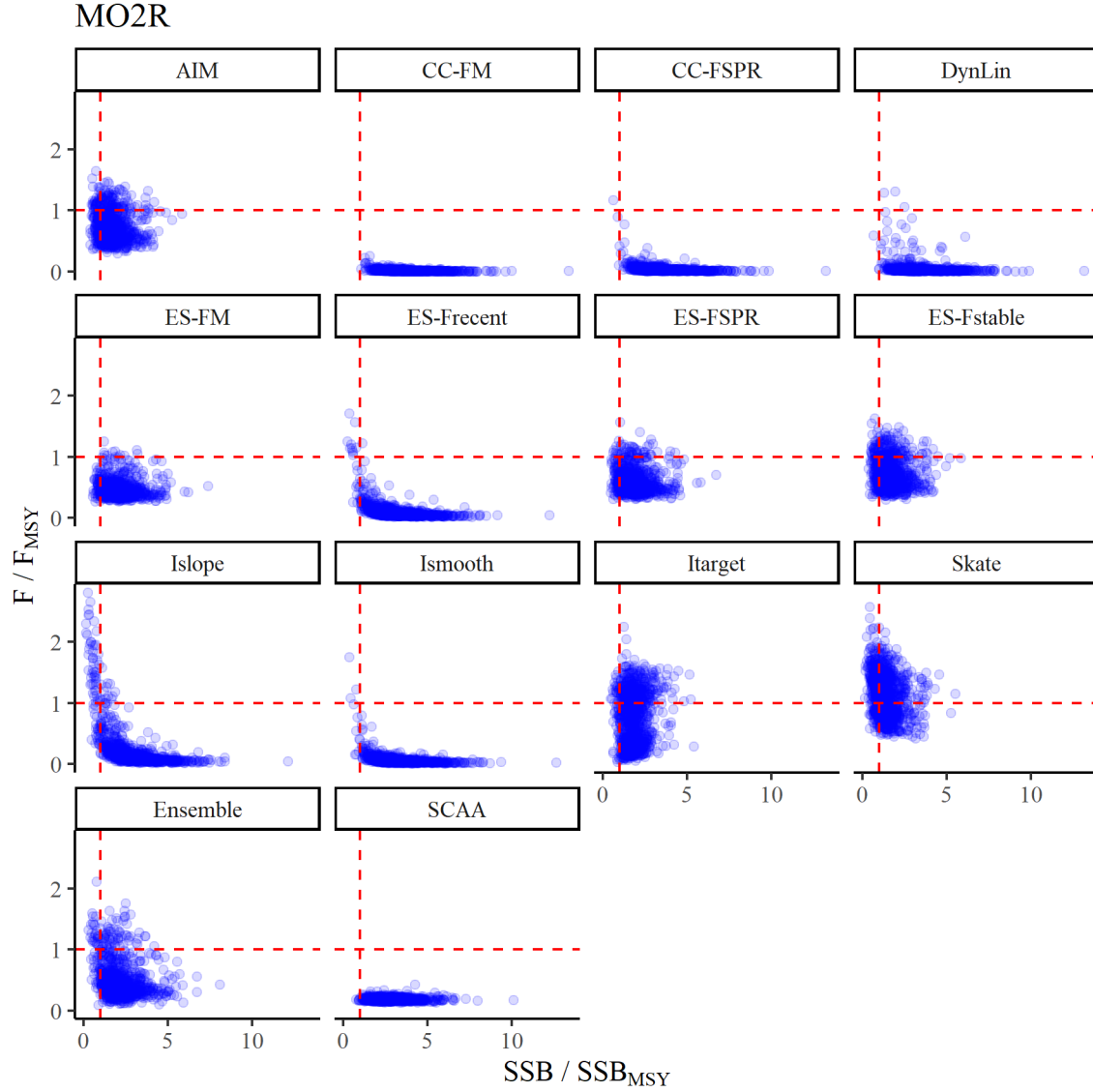


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