Tanner Crab Appendix A:
No Survey Corner Stations Sensitivity Study

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Introduction

In the face of expanding survey commitments, as well as simultaneous reductions in survey budgets and sea-going personnel, the Resource and Conservation Ecology (RACE) division of the Alaska Fisheries Science Center is considering approaches to redistributing sampling effort from the annual Eastern Bering Sea (EBS) Shelf bottom trawl to other surveys such as that in the Northern Bering Sea. When the EBS survey began in the early 1970s, the focus of the survey was primarily on the Bristol Bay region. Over the mid-1970s and early '1980's the survey expanded to the west and north, reaching its current configuration in 1987. The survey grid now consists 376 stations, the majority of which are located on a 20 nmi x 20 nmi grid (Figure 1). However, the remaining stations are located at "corners" of the rectangular grid to provide higher density sampling in areas around the Pribilof Islands and St. Matthew Island to better characterize abundance of blue king crab in these areas. Corner stations have been included in the sampling grid since 1982.

One suggestion to reduce survey effort in the EBS survey is to eliminate the high density corner stations from the sampling grid. However, it is unclear what effect this would have on assessments which rely on data from the EBS survey to provide annual size compositions, as well as abundance and biomass indices. The spatial distribution of Tanner crab is partially concentrated in the high density sampling area surrounding the Pribilof Islands and extends slightly into the high density sampling area surrounding St. Matthew Island. Thus, dropping the corner stations in future surveys

is expected to alter the annual estimates of abundance, biomass, and size composition relative to surveys which included those stations. Here, I consider the potential impact of "no corner stations" on the Tanner crab assessment by re-fitting the 2021 assessment model with EBS survey abundance, biomass, and size compositions recalculated using no corner stations, then comparing the results to those from the 2021 assessment. First, though, I compare the time series of survey abundance and biomass estimates (and confidence intervals), as well as size compositions, obtained by excluding corner stations with those obtained by including the corner stations for the 1975-2021 EBS survey data. I also compare the effective sample sizes associated with both sets of size compositions.

Survey biomass and abundance

Design-based estimates of EBS-wide survey biomass and abundance were calculated using standard equations from the EBS trawl survey haul data with corner stations removed ("NoCSs") in all years, with the areas associated with sampling strata revised to reflect this (Figures 2 - 5). Compared with the standard estimates including the corner stations ("WithCSs"), dropping the corner stations had relatively little impact on the estimates of trends in EBS-wide survey biomass and abundance.

Survey size compositions

Similar to results for survey biomass and abundance, dropping the corner stations had little impact in most years on EBS-wide normalized survey size compositions (Figures 6-11). The only notable differences occurred for males and (to a lesser extent) immature females in 1986.

Effective sample sizes

As one would expect, dropping the corner stations resulted in somewhat lower numbers of crab sampled and associated sample sizes (Figures 12-15) after 1981 (as previously noted, corner stations have been included in sampling grid since 1982).

Assessment results

To characterize the effect of dropping the corner stations from future surveys, the 2021 assessment model (labeled "WithCSs" here) was re-run with the corner stations dropped from all previous surveys (i.e., 1975-2021). This was considered to be the scenario (labeled "noCSs" here) which would exhibit the largest possible changes in assessment quantities relative to current survey sampling practices. Annual estimates of recruitment with corner stations dropped were almost identical to those from the 2021 assessment (Figure 16). Estimated trends in population biomass and abundance were also similar (Figures 17-18), although the overall levels for mature males and females were slightly higher when the corner stations were not included. Estimates of most population processes (i.e., growth, molt to maturity), fishery characteristics (fishing mortality rates, fleet selectivities and retention functions), and survey characteristics (cathchability and selectivity) were essentially identical between the two scenarios (not shown). The difference was traced back to slightly lower estimates of natural mortality (M) on mature crab without corner stations (Figure 19). As a result, management quantities such as average recruitment, F_{MSY}, and F_{OFL} were essentially unchanged when corner stations were dropped while OFL and biomass-related quantities were slightly larger (Figures 20 and 21).

Conclusions

Dropping corner stations in the EBS trawl survey sampling grid did not appear to have a substantial effect on either survey trends or assessment results for Tanner crab. Tanner crab abundance is typically quite small (relative to the total EBS population) near St. Matthew Island, so one would expect little effect from dropping corner stations in the St. Matthew sampling stratum. Conversely, Tanner crab abundance can be much higher near the Pribilof Islands, so dropping corner stations in the Pribilof Islands sampling stratum might have been expected, given the patchy nature of crab distributions, to have a large effect, but that was not the case.

However, these stations were added to provide better monitoring of changes in blue king crab population trends, so judging the efficacy of these stations to crab assessments solely on the basis of their impact on the Tanner crab assessment would be shortsighted. In addition, because snow crab abundance is much higher than that for Tanner crab in the St.Matthew Island sampling stratum, the corner stations may also be much more important for assessing snow crab population trends than seems to be the case for Tanner crab . Consequently, I would suggest the effects of dropping the corner stations on other crab stocks needs to be examined before taking any action to change the current sampling design.

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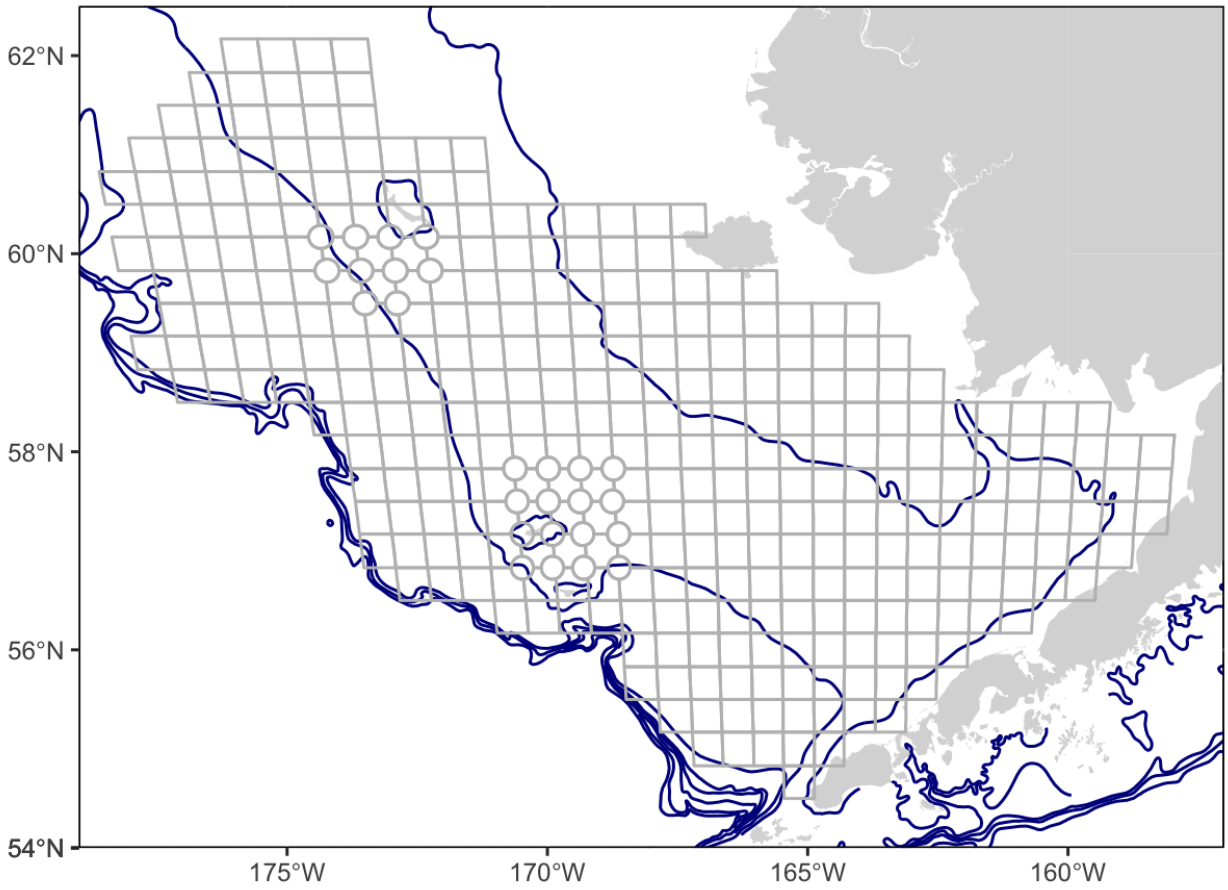


Figure 1: Current EBS shelf survey grid.

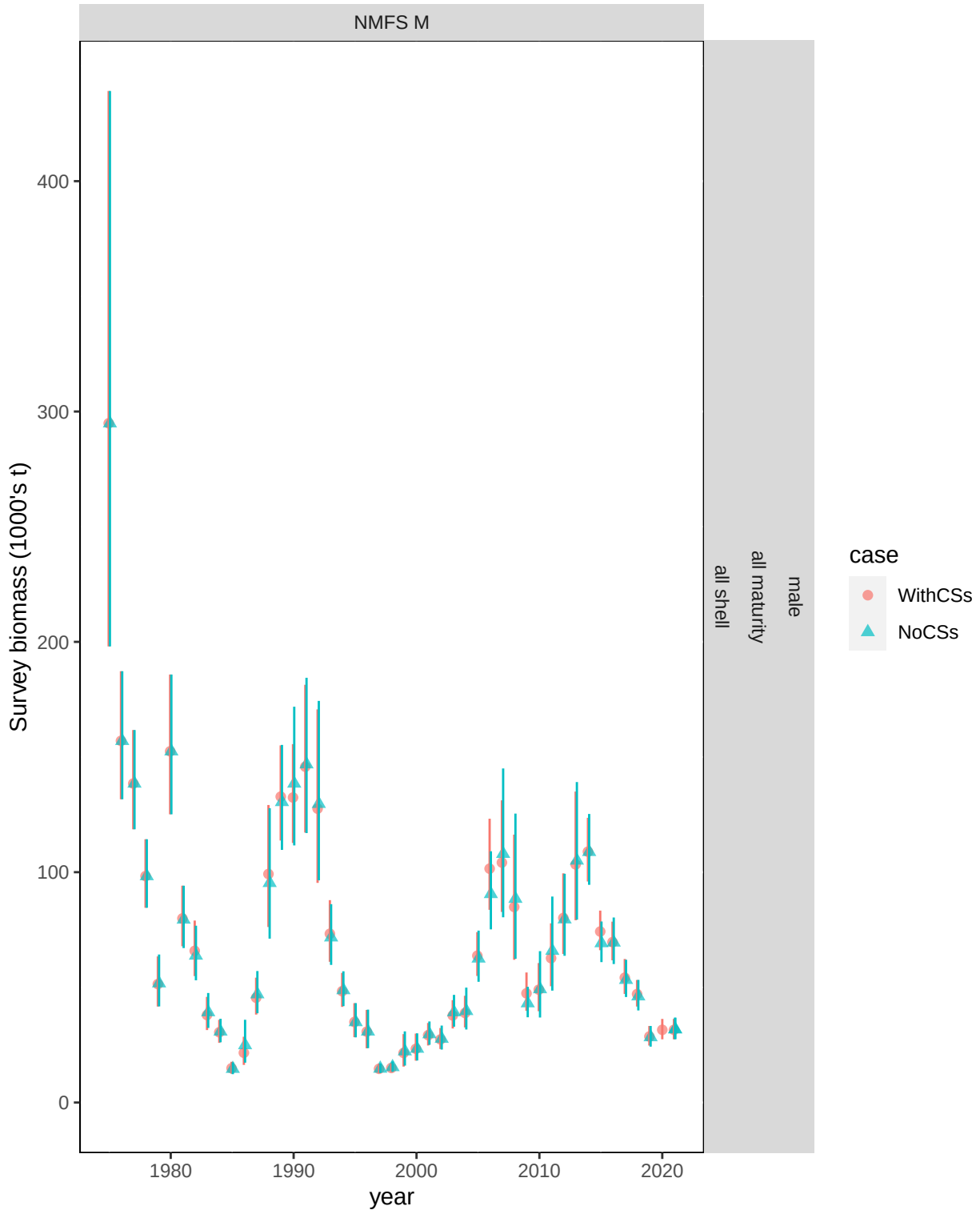


Figure 2: Comparison of the survey biomass time series for males with ("WithCSs") and without ("noCSs") corner stations.

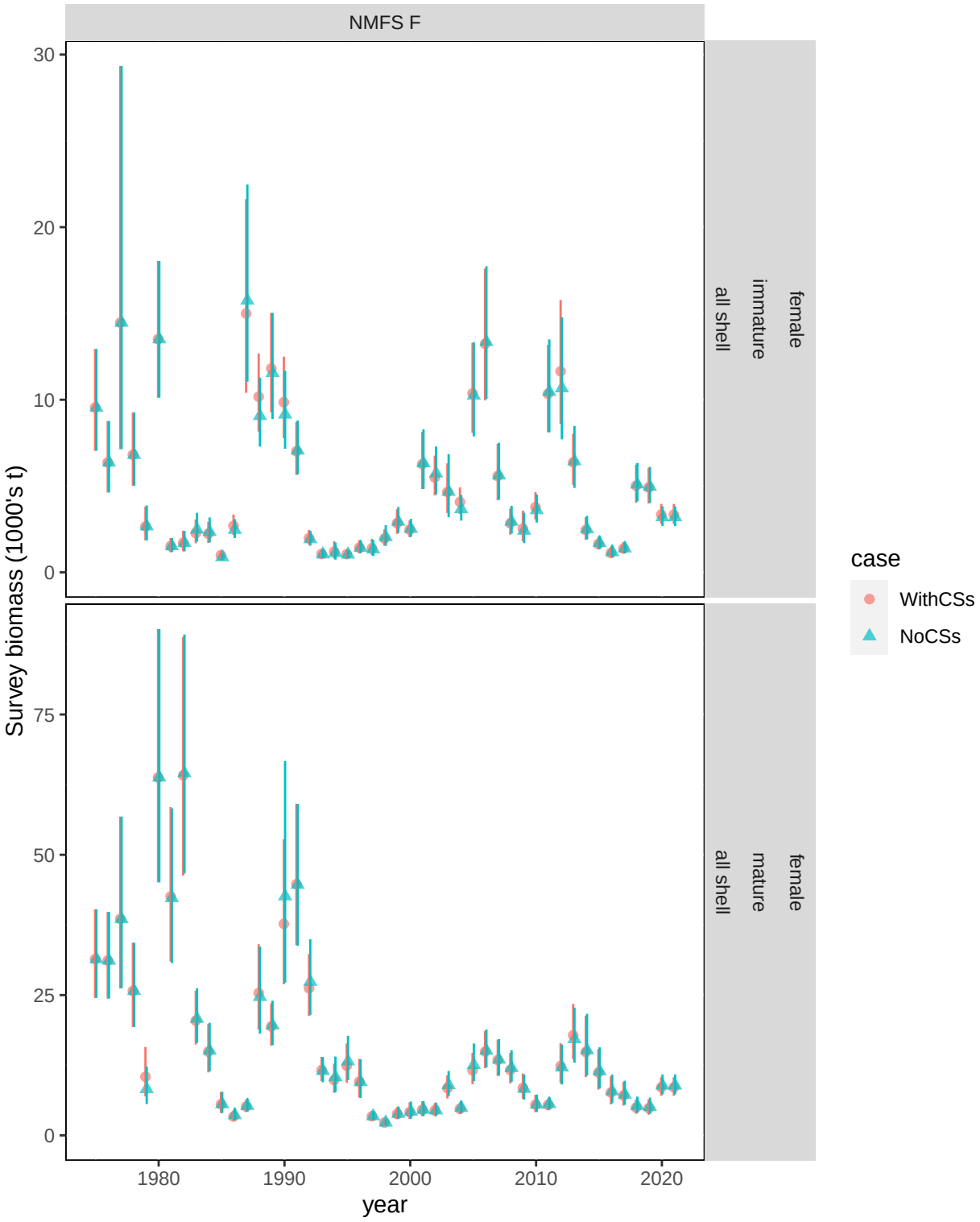


Figure 3: Comparison of the survey biomass time series for females with ("WithCSs") and without ("noCSs") corner stations.

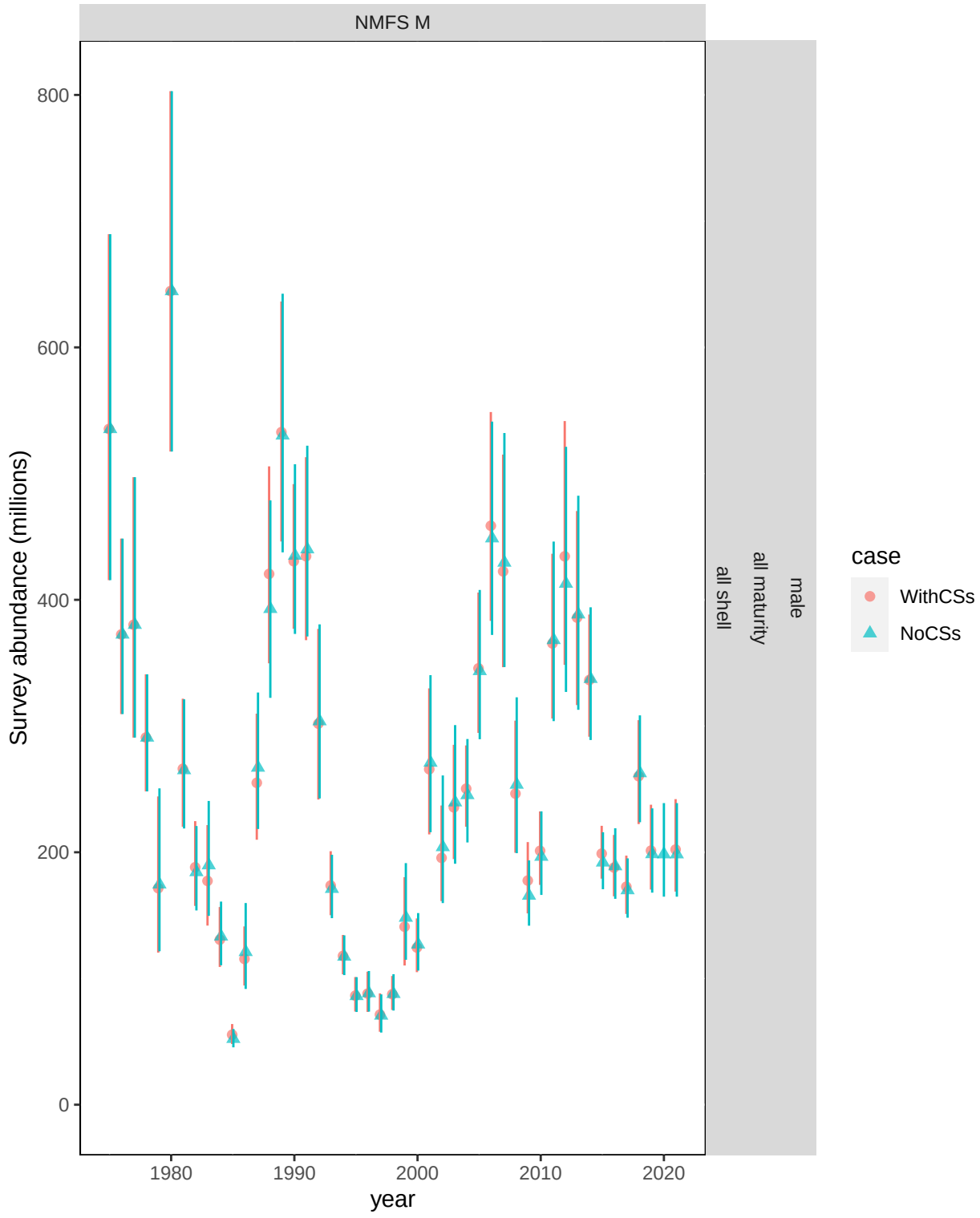


Figure 4: Comparison of the survey abundance time series for males with ("WithCSs") and without ("noCSs") corner stations.

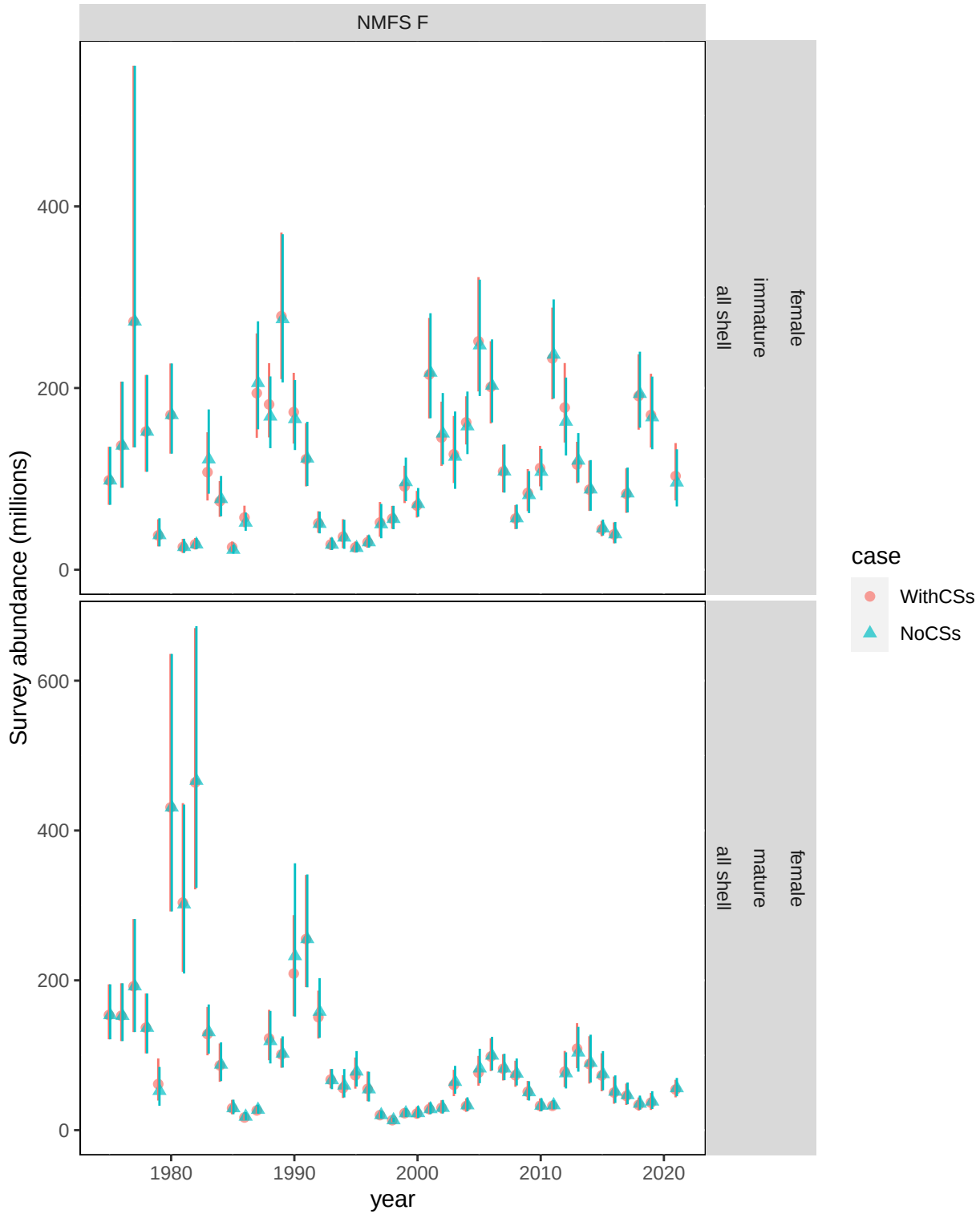


Figure 5: Comparison of the survey abundance time series for females with ("WithCSs") and without ("noCSs") corner stations.

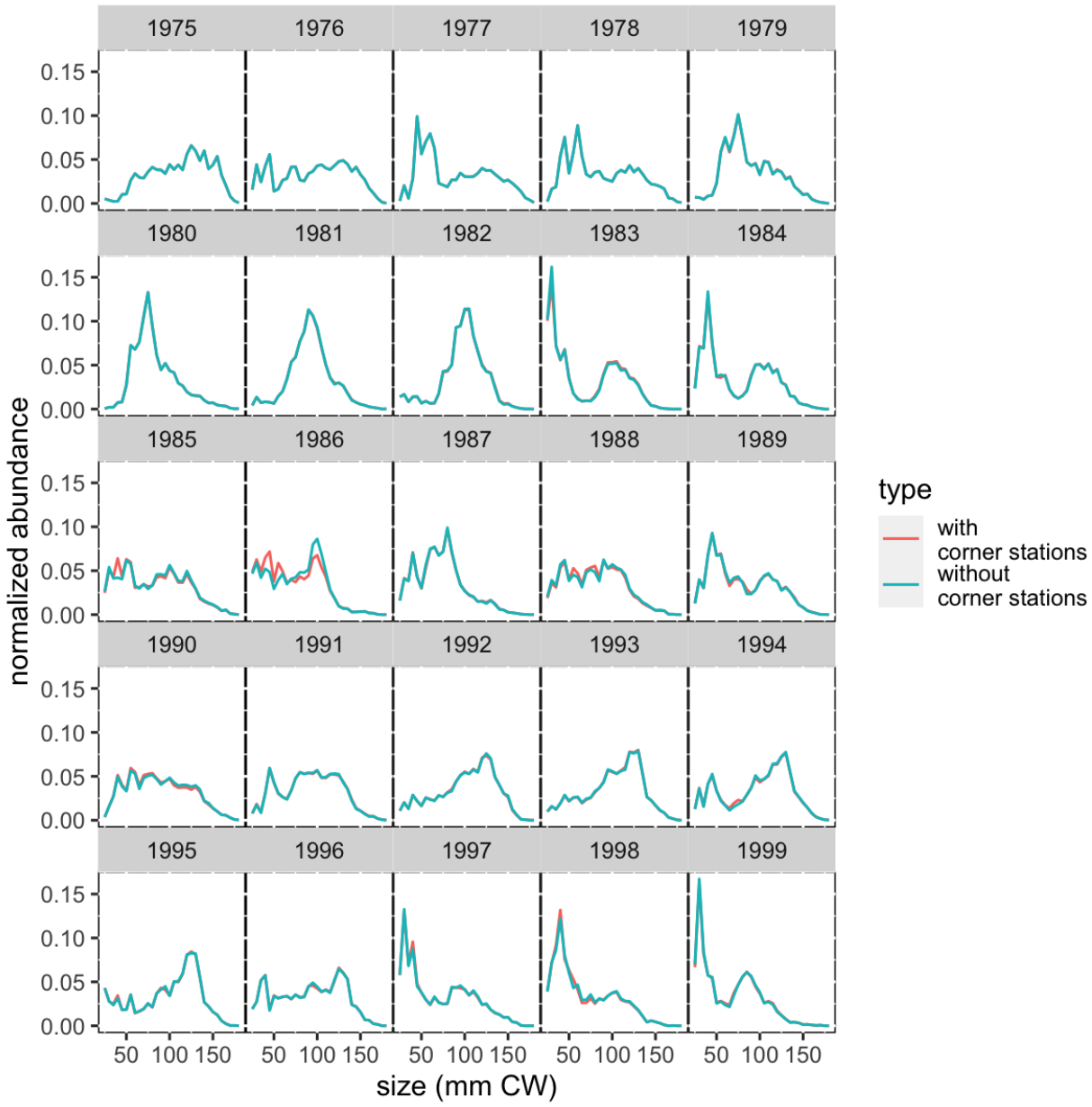


Figure 6: Comparison of EBS-wide (normalized) survey size compositions for male Tanner crab (1975-1999).

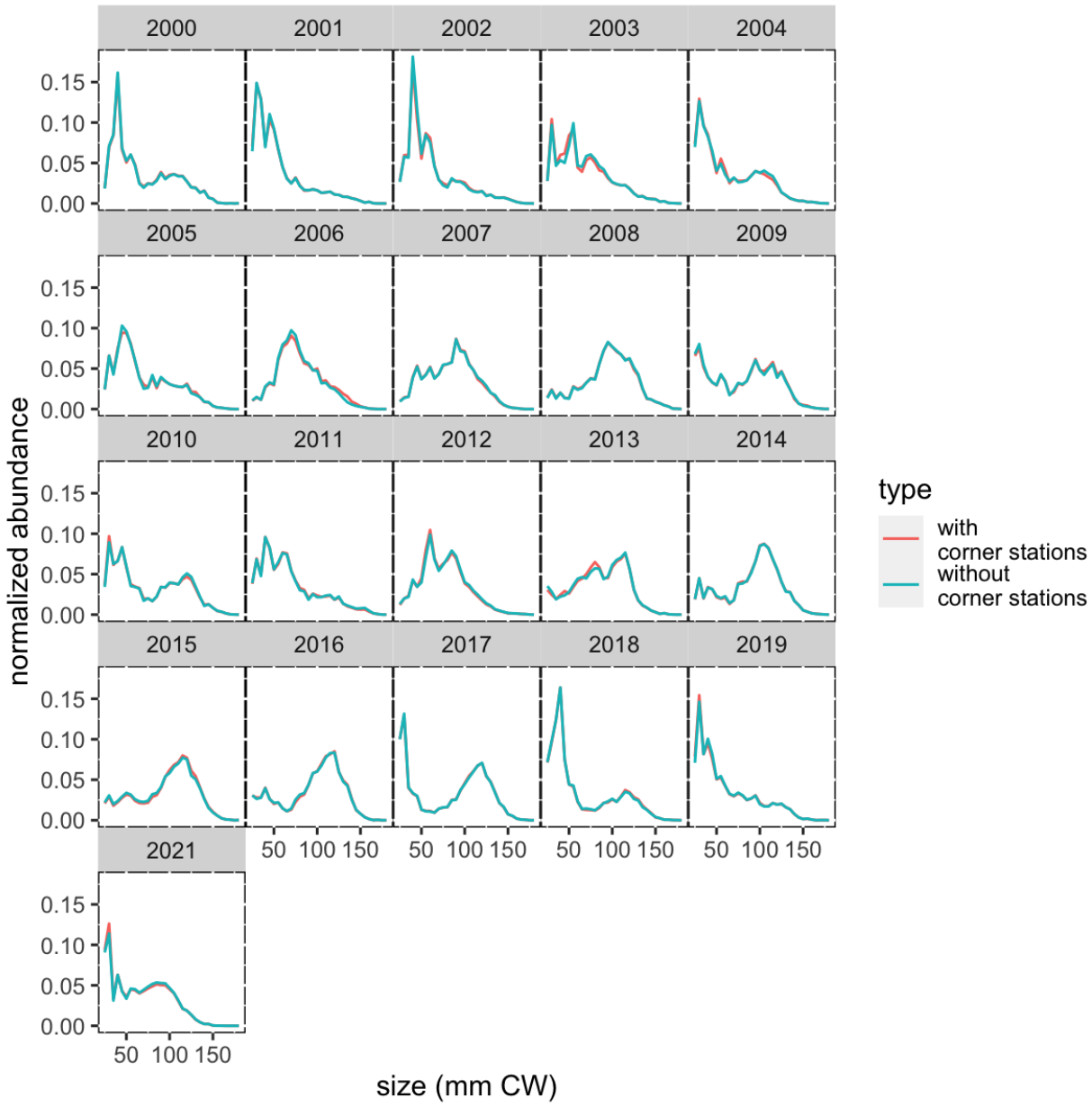


Figure 7: Comparison of EBS-wide (normalized) survey size compositions for male Tanner crab (2000-2021).

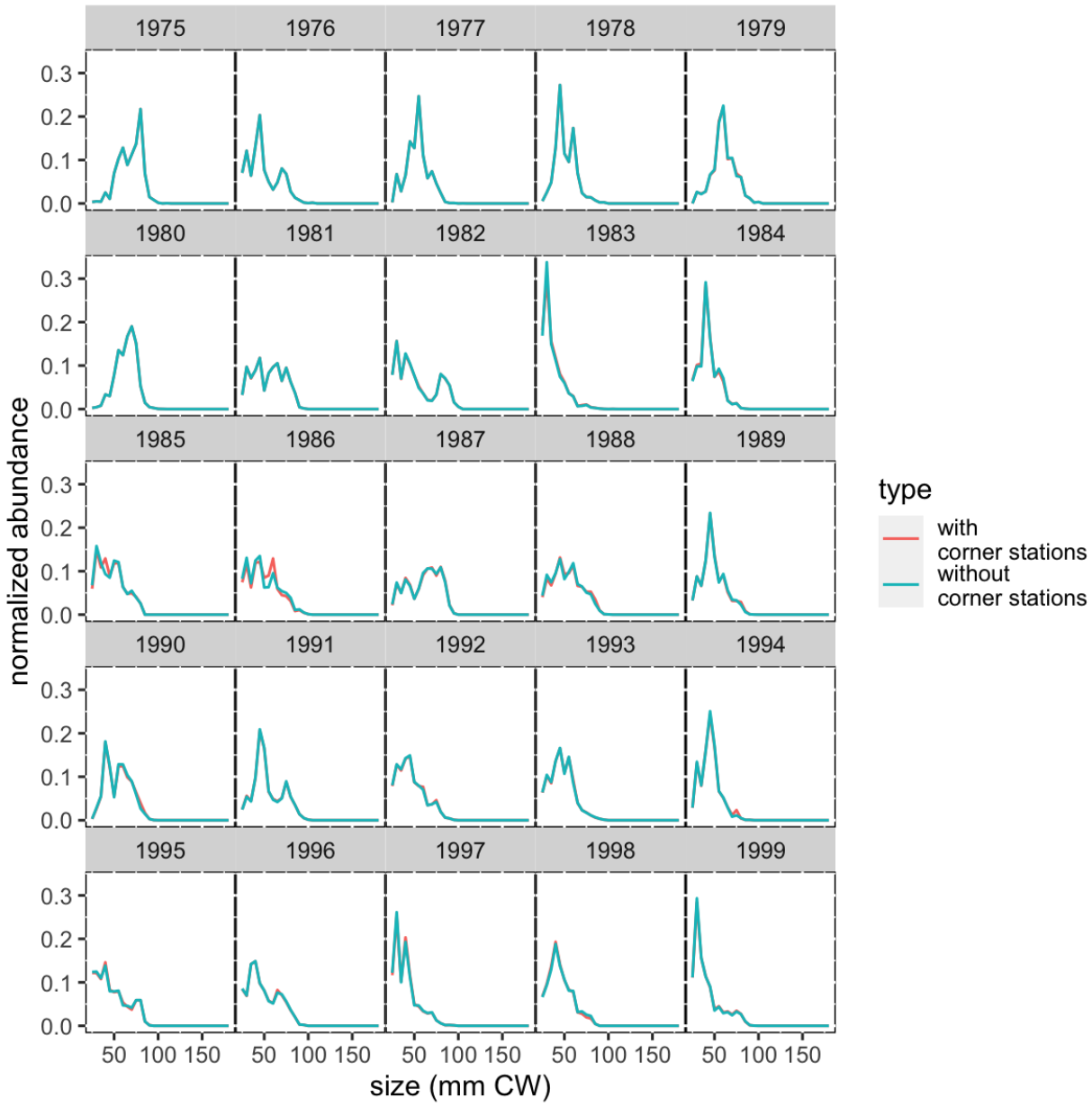


Figure 8: Comparison of EBS-wide (normalized) survey size compositions for immature female Tanner crab (1975-1999).

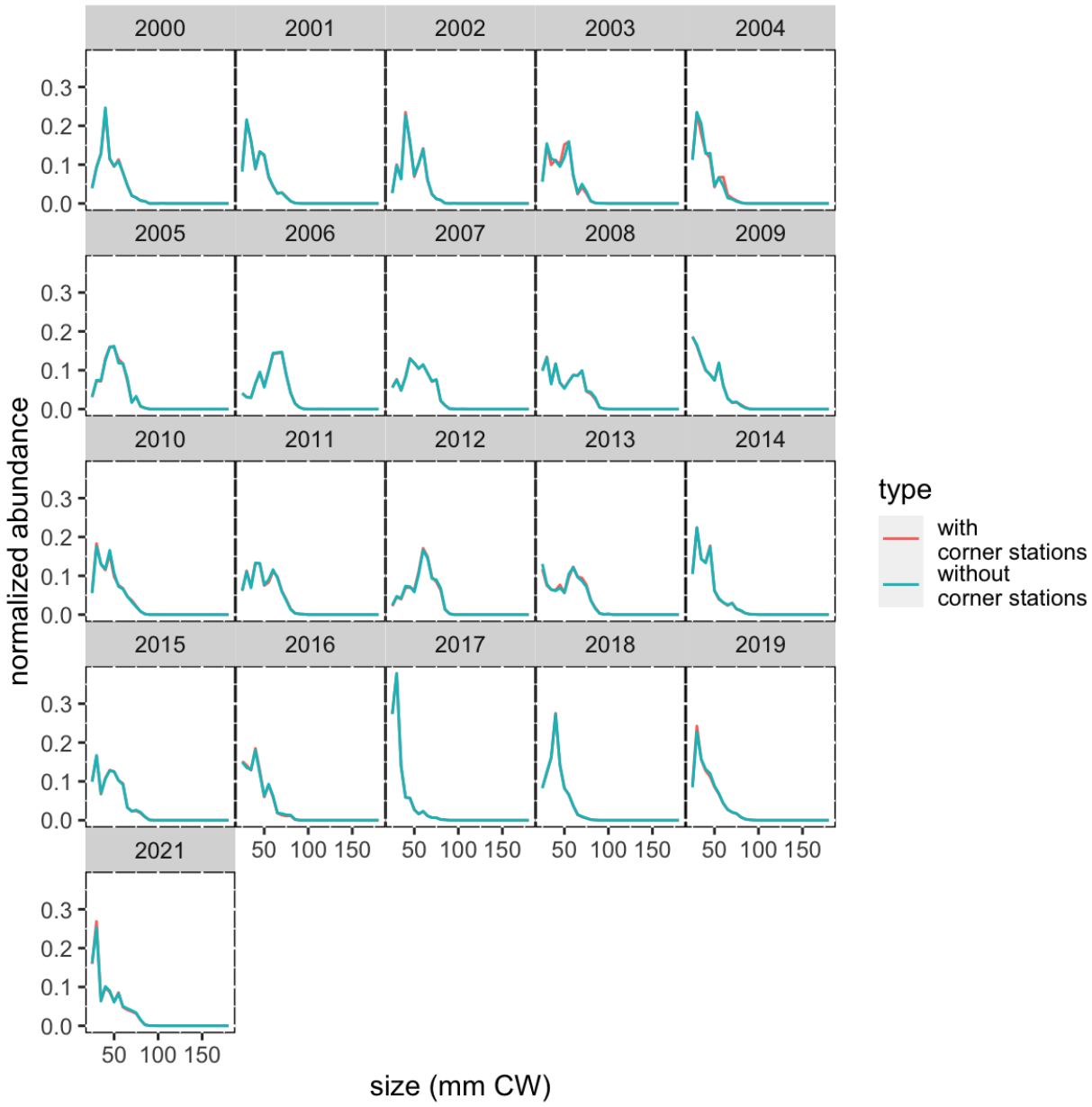


Figure 9: Comparison of EBS-wide (normalized) survey size compositions for immature female Tanner crab (2000-2021).

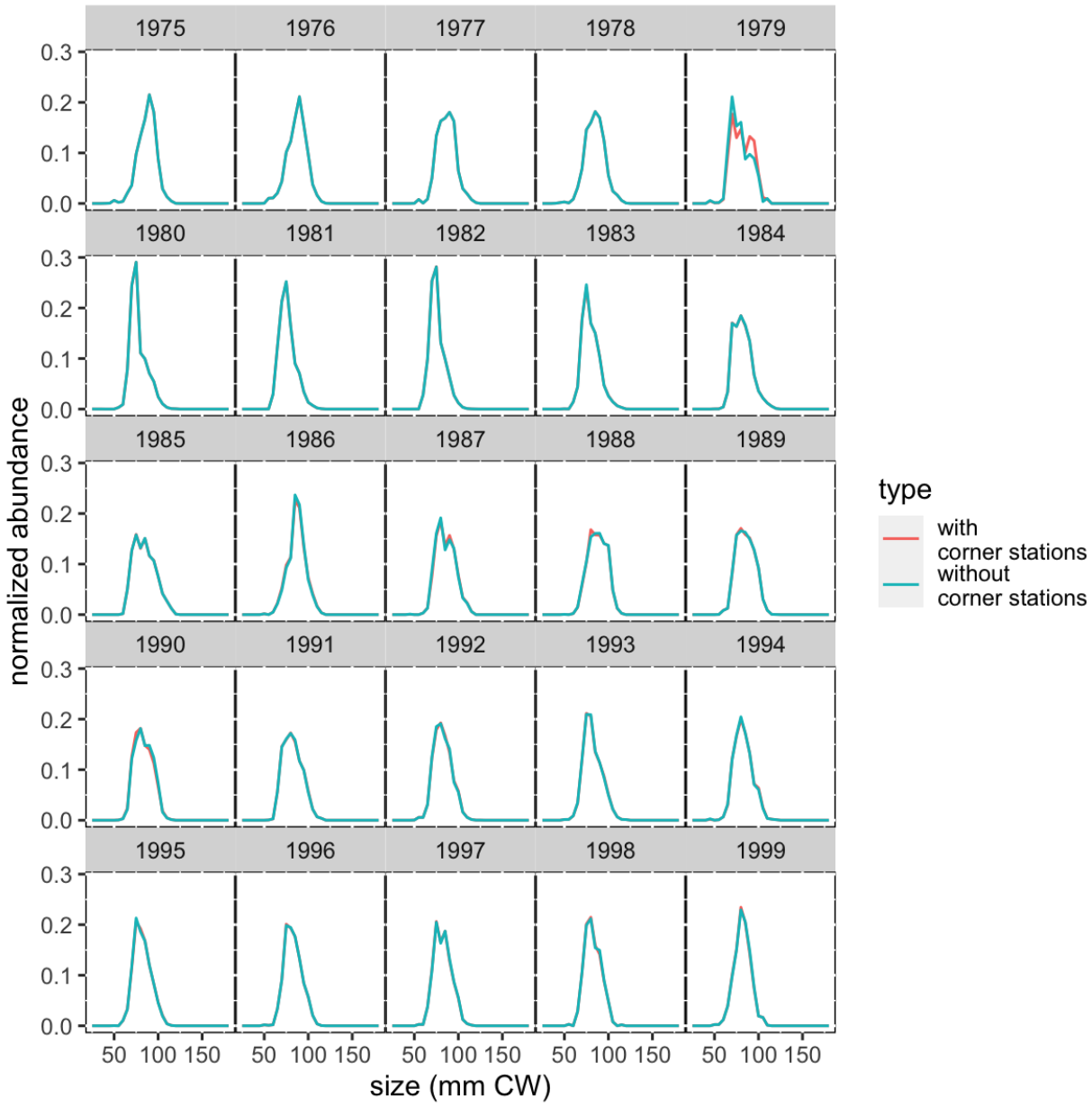


Figure 10: Comparison of EBS-wide (normalized) survey size compositions for mature female Tanner crab (1975-1999).

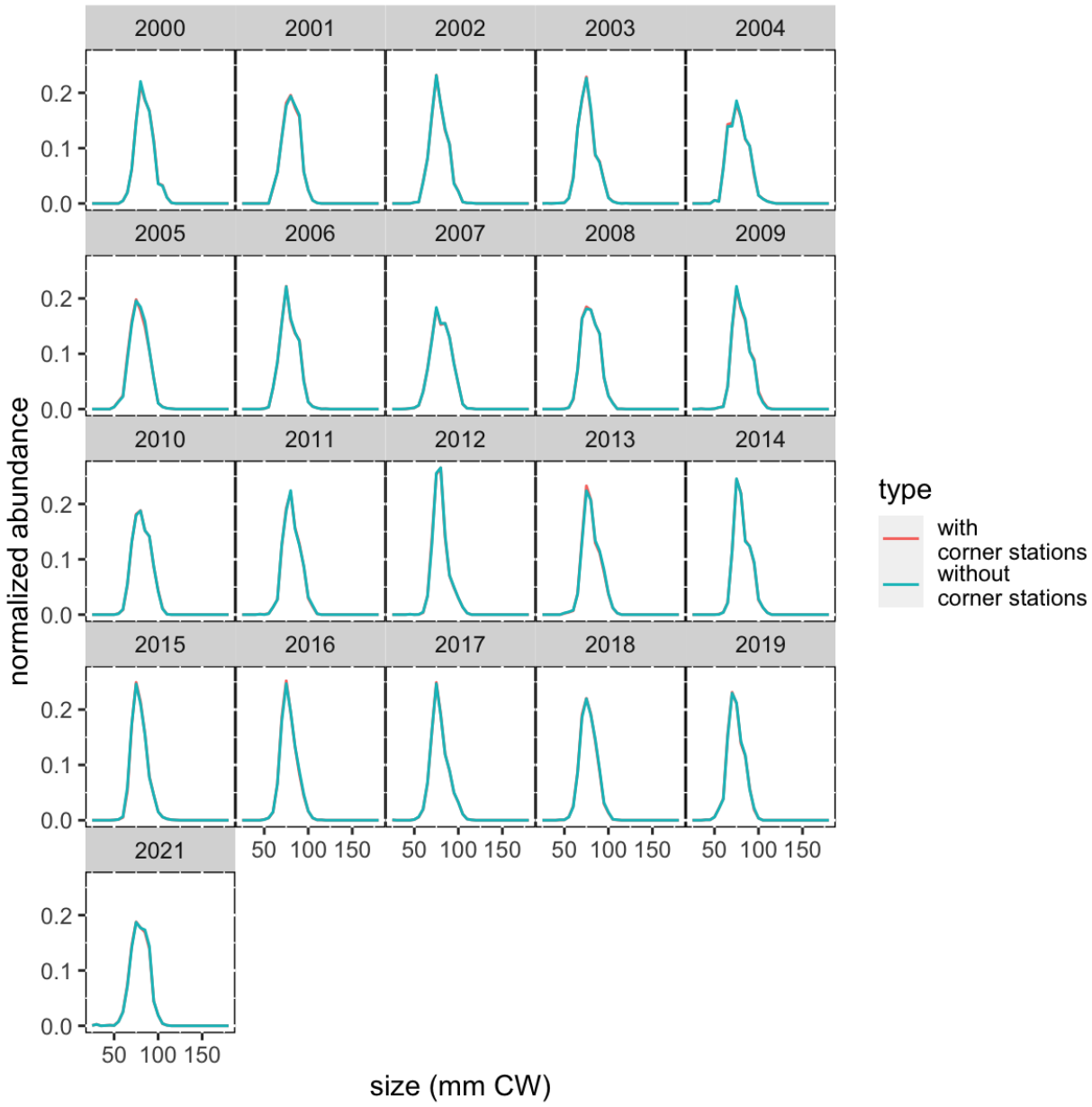


Figure 11: Comparison of EBS-wide (normalized) survey size compositions for mature female Tanner crab (2000-2021).

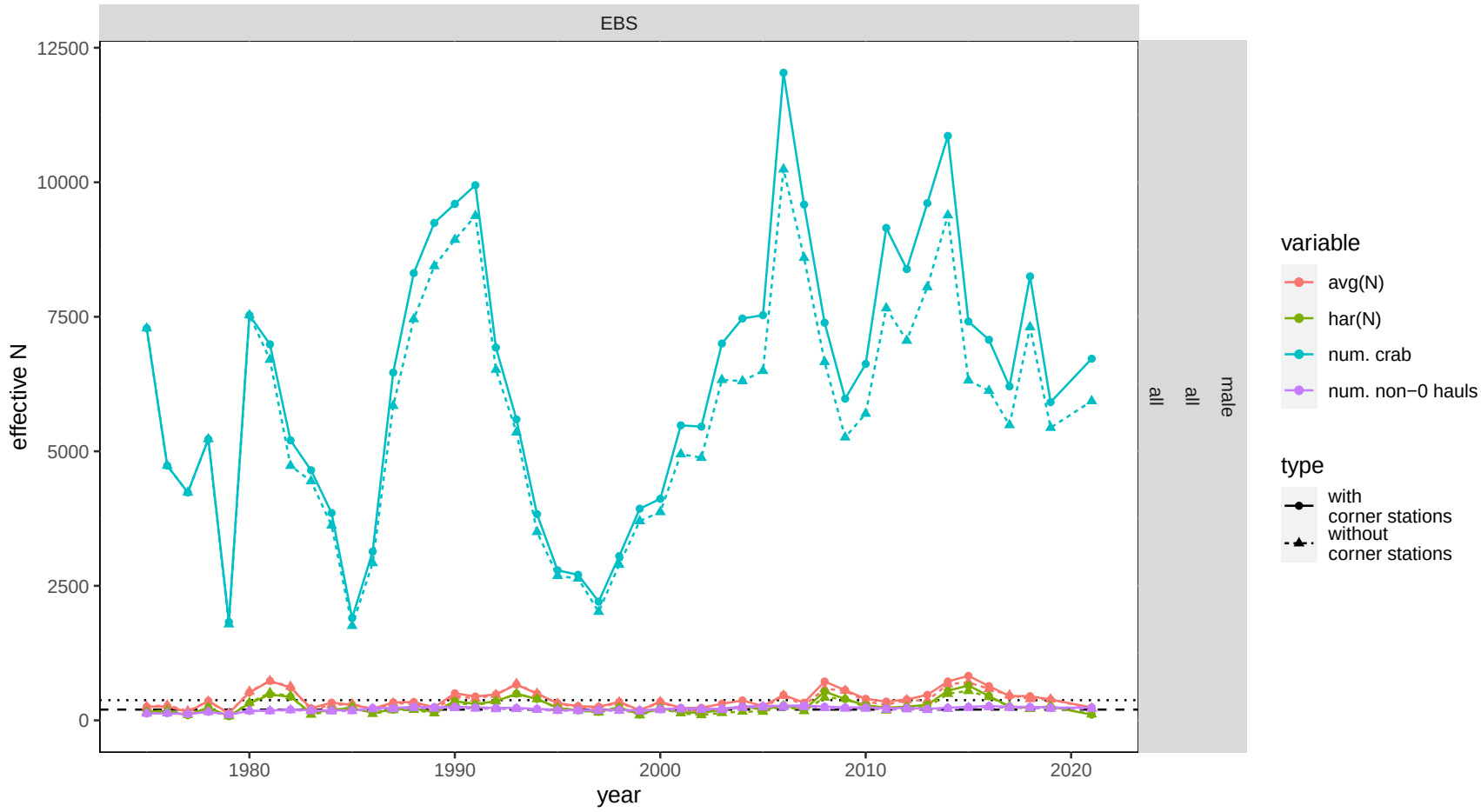


Figure 12: Comparison of various sample sizes between survey results with (solid lines) and without (dotted lines) corner stations for male crab: 1) red: arithmetic mean effective N (from two-stage bootstrapping), 2) green: harmonic mean effective N (from two-stage bootstrapping), 3) blue: numbers of males measured, and 4) purple: number of hauls where males were caught.

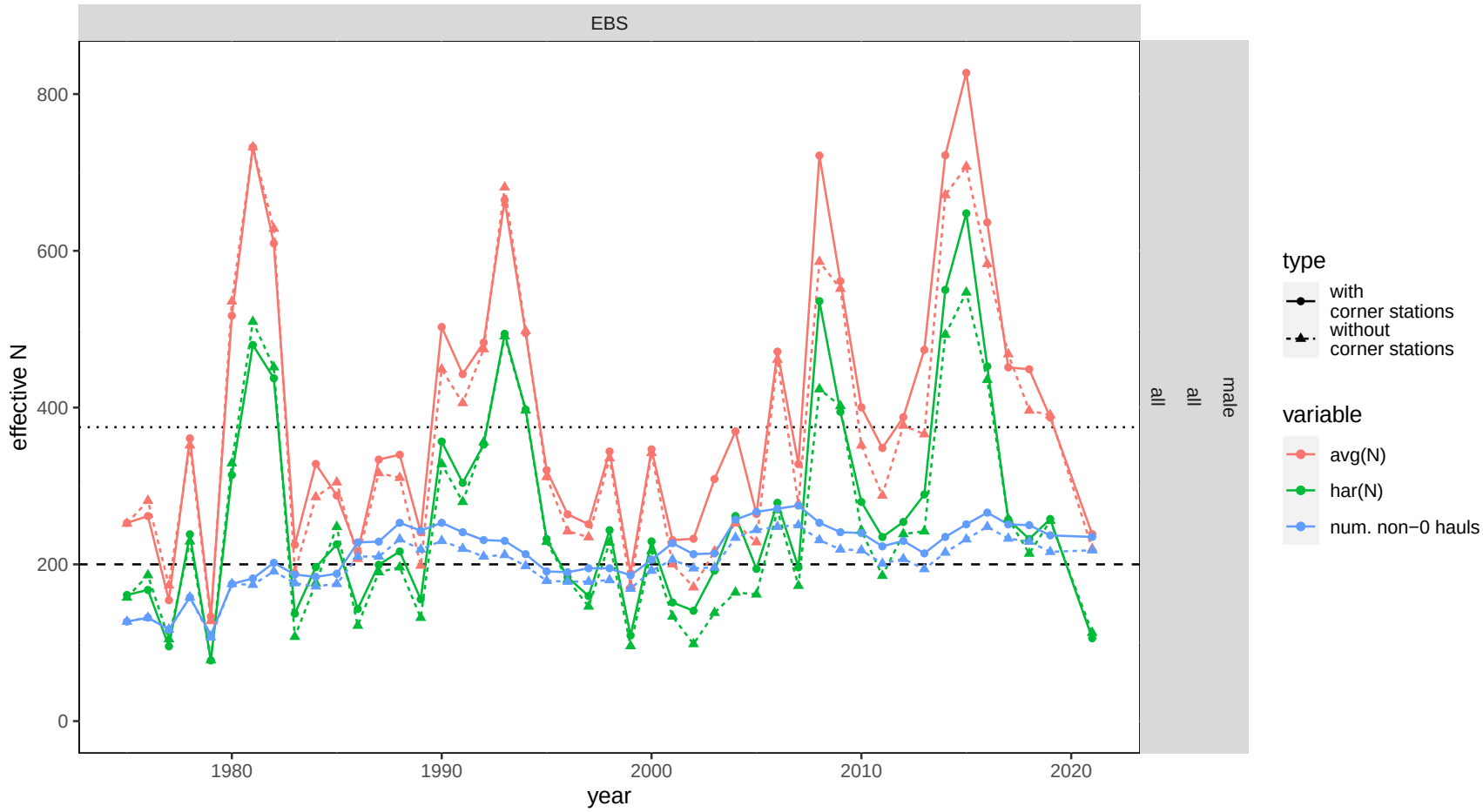
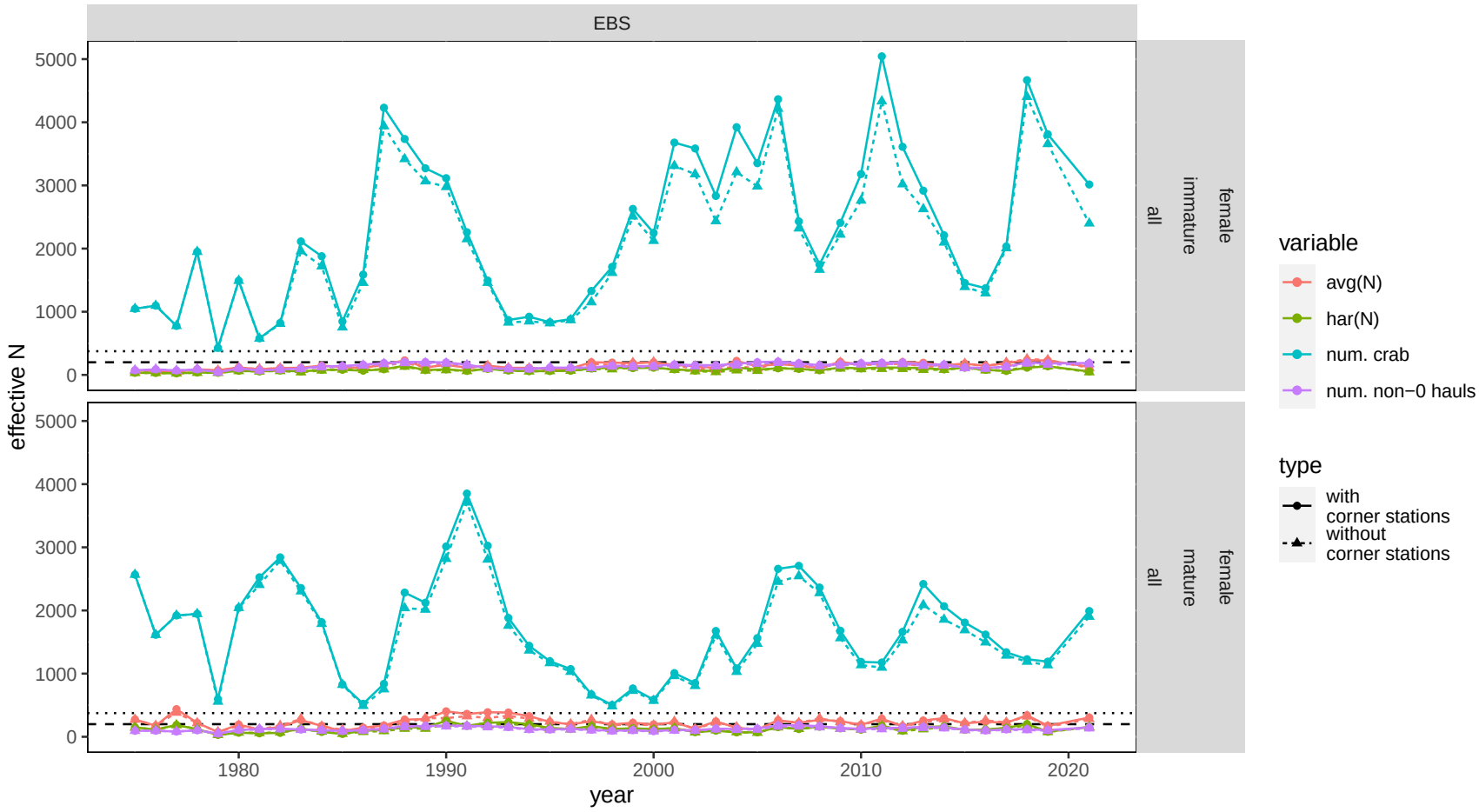


Figure 13: Comparison of various sample sizes between survey results with (solid lines) and without (dotted lines) corner stations for male crab: 1) red: arithmetic mean effective N (from two-stage bootstrapping), 2) green: harmonic mean effective N (from two-stage bootstrapping), and 3) blue: number of hauls where males were caught. Detailed view.



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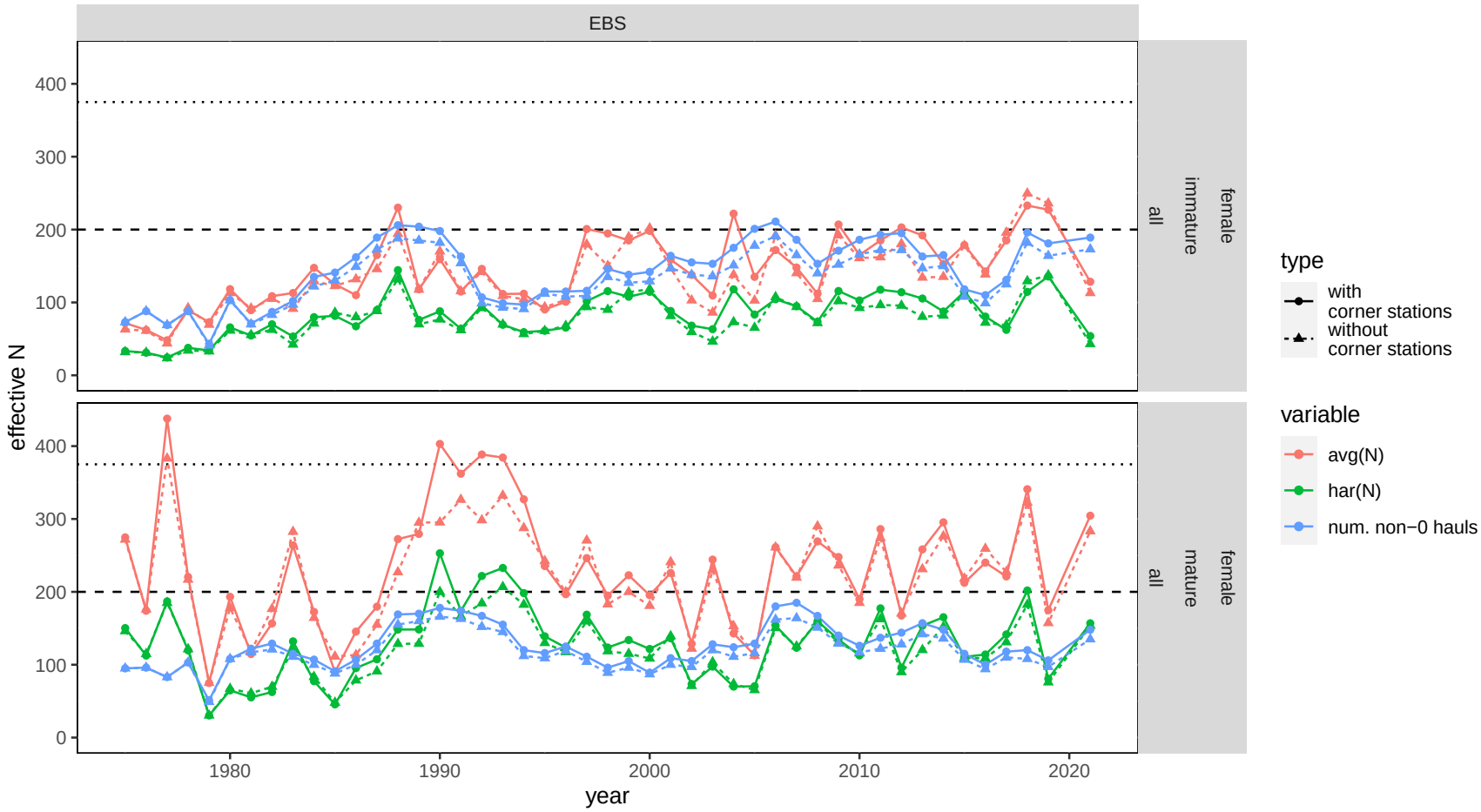

Figure 15: Comparison of various sample sizes between survey results with (solid lines) and without (dotted lines) corner stations for female crab: 1) red: arithmetic mean effective N (from two-stage bootstrapping), 2) green: harmonic mean effective N (from two-stage bootstrapping), and 3) blue: number of hauls where males were caught. Detailed view.

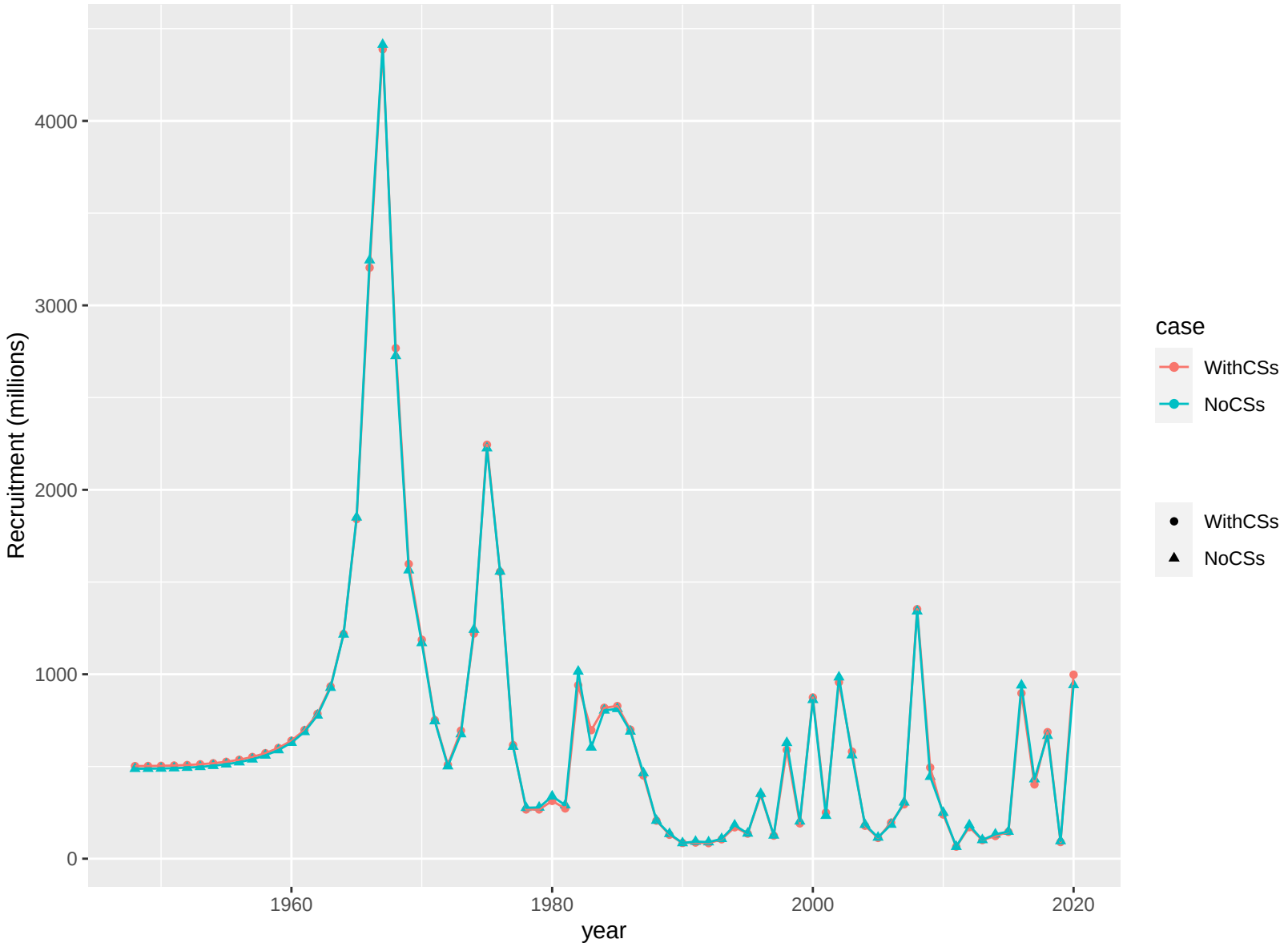

Figure 16: Estimated annual recruitment.

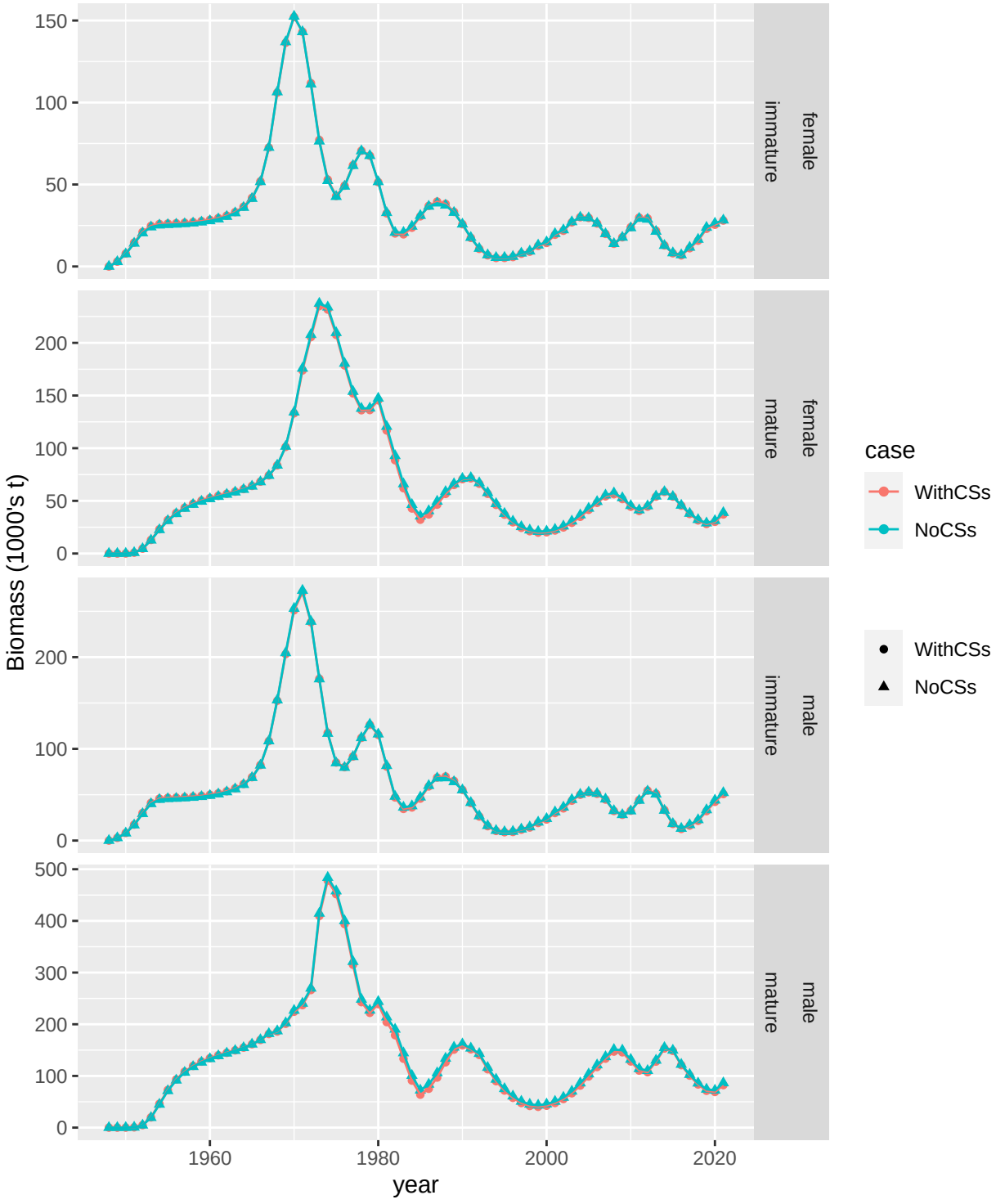

Figure 17: Population biomass trends.

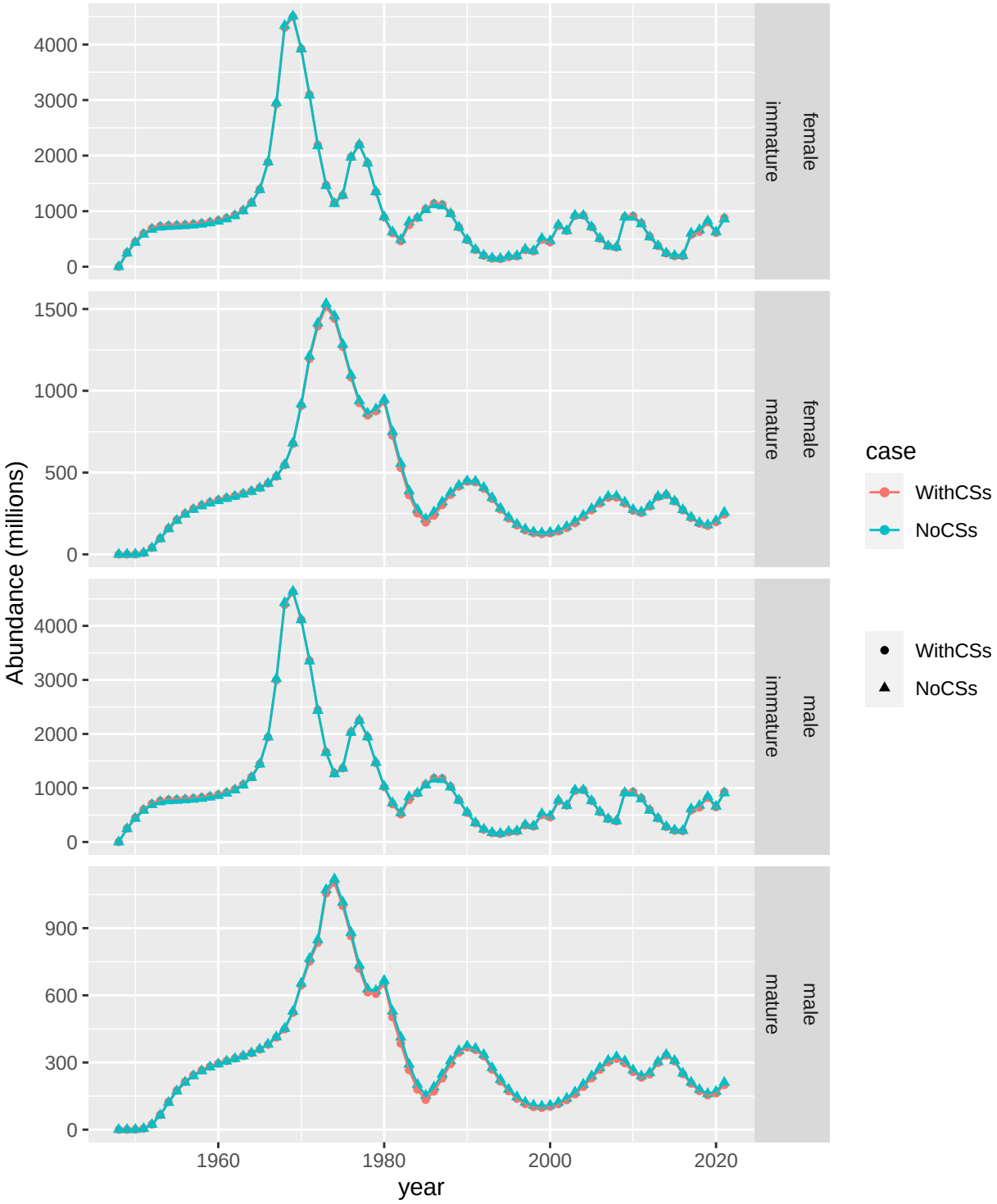

Figure 18: Population abundance trends.

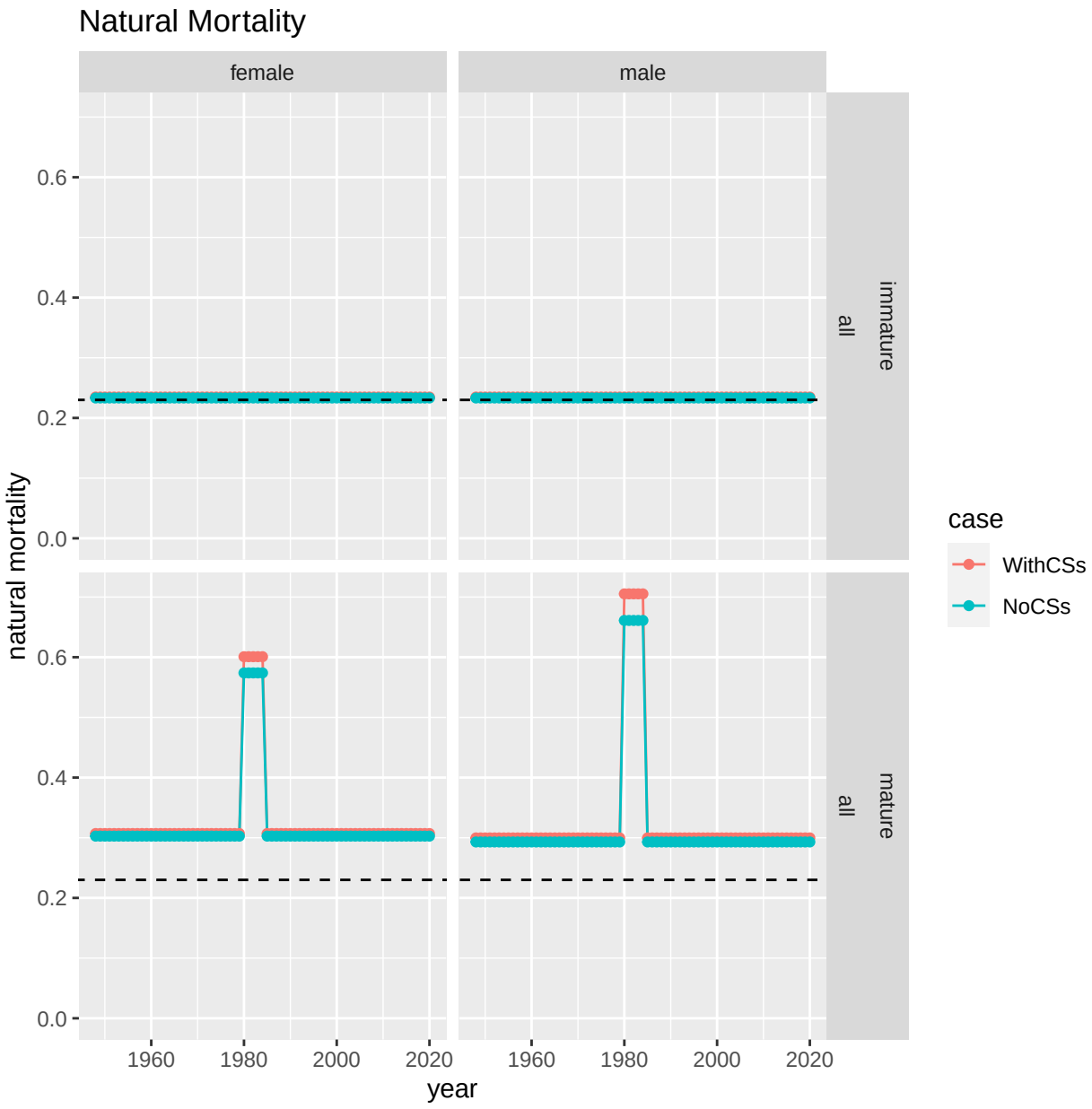

Figure 19: Estimated natural mortality rates, by year.

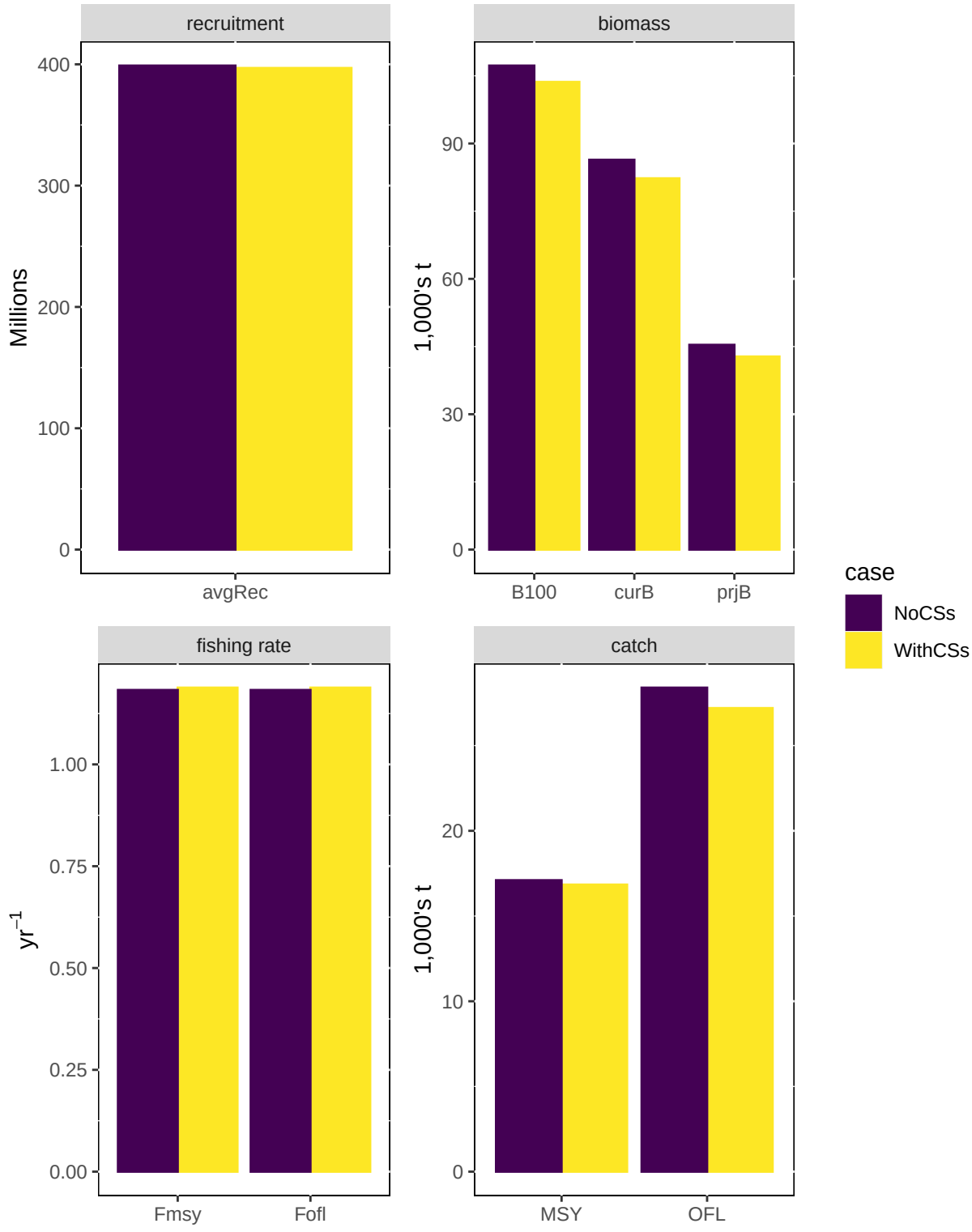

Figure 20: Comparison of management quantities among model scenarios.

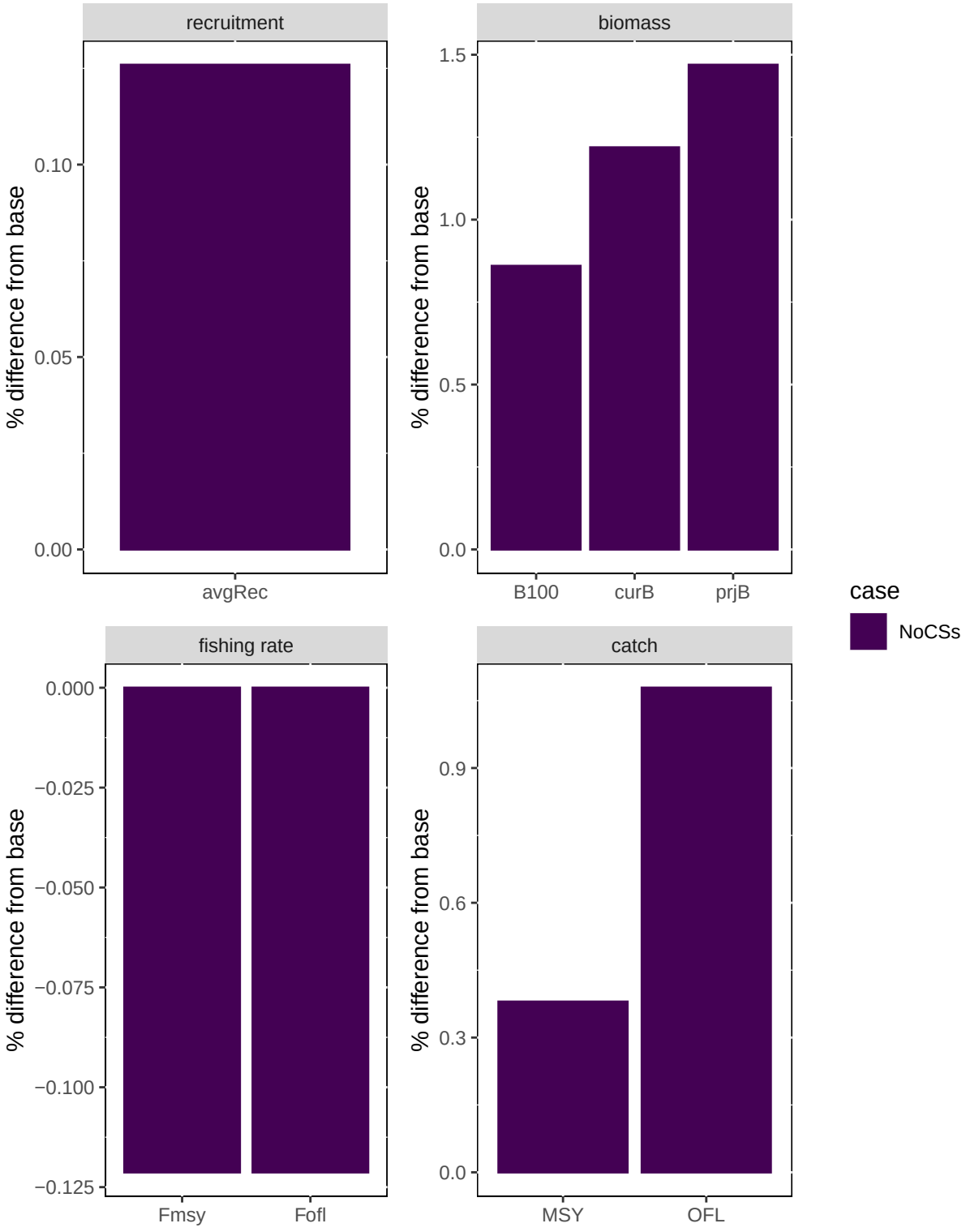

Figure 21: Comparison of differences in management quantities among model scenarios, relative to the base case ("WithCSs").