Multiple-batch spawning: a risk-spreading strategy disarmed by highly intensive size-selective fishing rate

Supplementary material file

Sara Hočevar* [a], Jeffrey A. Hutchings[a,b,c,d] and Anna Kuparinen [a]

[a] Department of Biological and Environmental Science, University of Jyväskylä, Jyväskylä, Finland

[b] Department of Biology, Dalhousie University, Halifax, Canada

[c] Institute of Marine Research, Flødevigen Marine Research Station, N-4817 His, Norway

[d] Department of Natural Sciences, University of Agder, N-4604 Kristiansand, Norway

Sara Hočevar	https://orcid.org/0000-0002-1294-0927
Jeffrey A. Hutchings	https://orcid.org/0000-0003-1572-5429
Anna Kuparinen	https://orcid.org/0000-0002-7807-8946

Proceedings of the Royal Society B: Biological Sciences

Article DOI: 10.1098/rspb.2022-1172

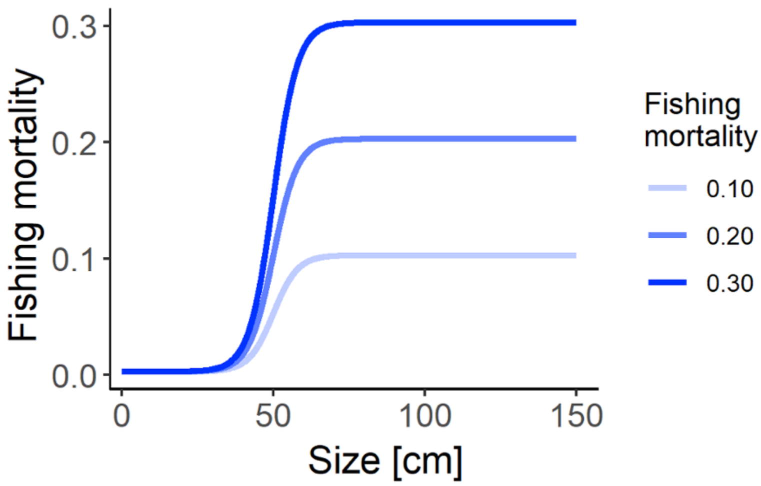

Figure S1. Fishing size selectivity. The line-plot illustrates 3 rates of simulated fishing mortality (0.10, 0.20 and 0.30) as a function of body size, with 45 cm being the smallest size sensitive to fishing gear (a bottom trawl).

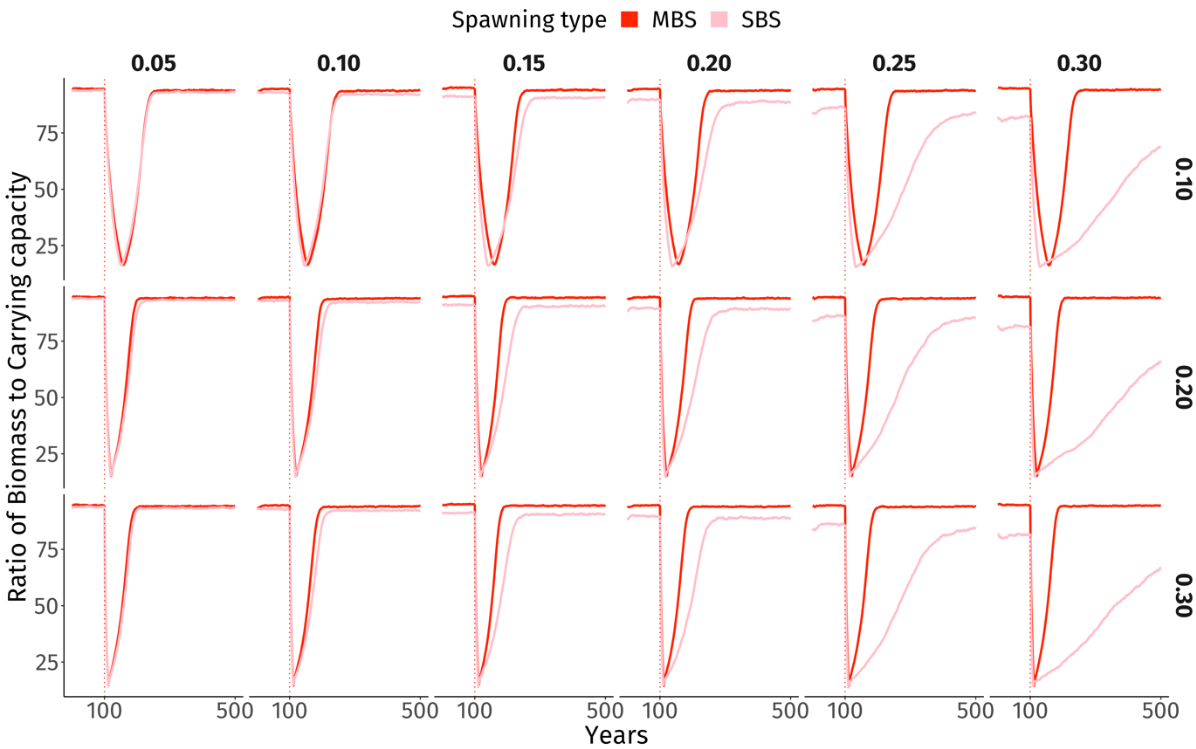

Figure S2. The biomass to carrying capacity ratio during 500 years of simulation period faceted against fishing pressure (row-wise) and environmental forcing (column-wise). The red and pink lines represent mean values of 50 replica simulations for each scenario combination of multiple (MBS; red coloured line) and single-batch spawning (SBS; pink coloured line) strategists. The vertical dashed line indicates the onset of the fishing period.

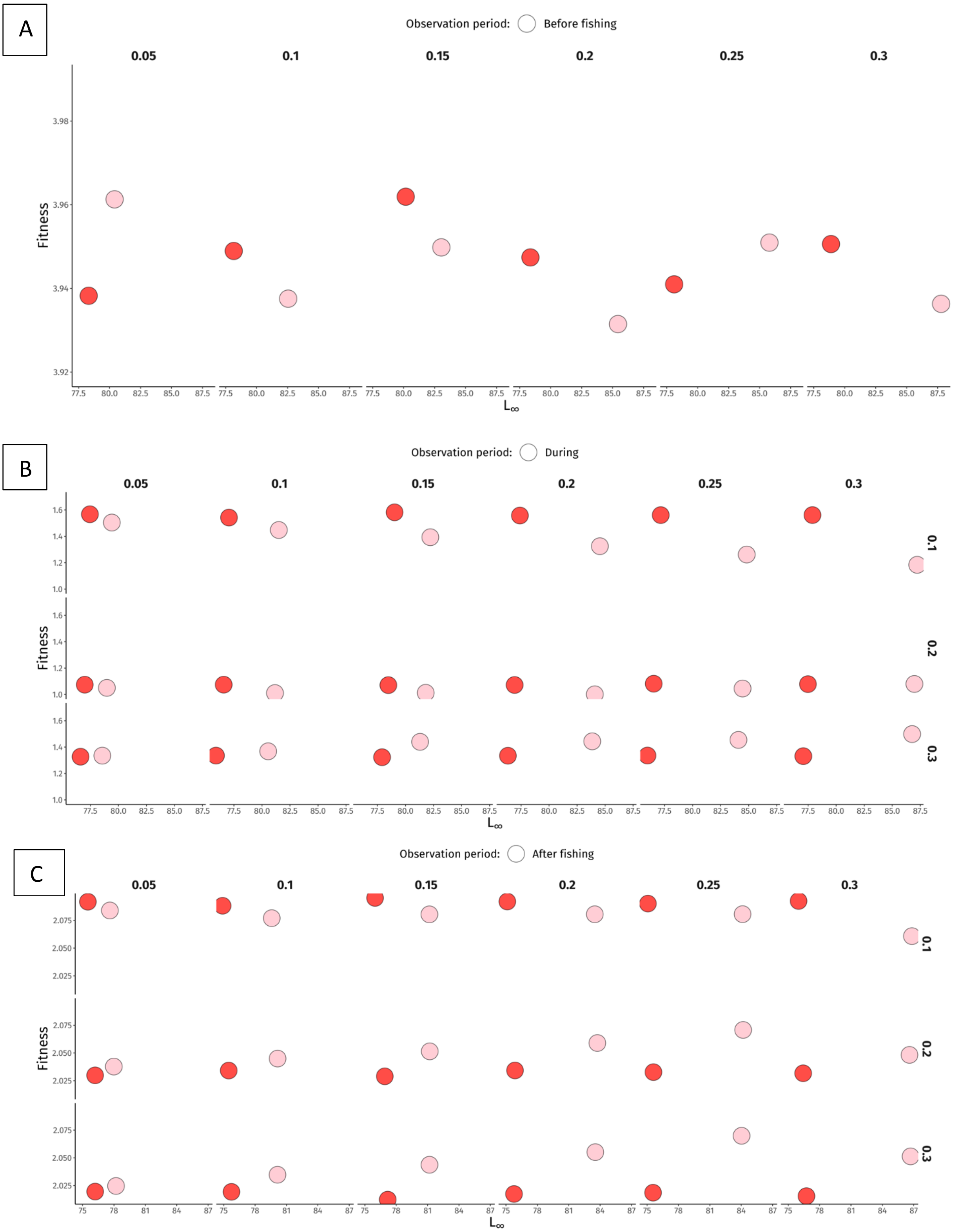

Figure S3. Closer look at average realised fitness of multiple (red) and single (pink) batch spawners before (A), during (B) and after (C) fishing, plotted against average asymptotic length L_∞ of mature adults and facetted for each combination of fishing (row-wise) and environmental (column-wise) pressure before, during and after fishing.

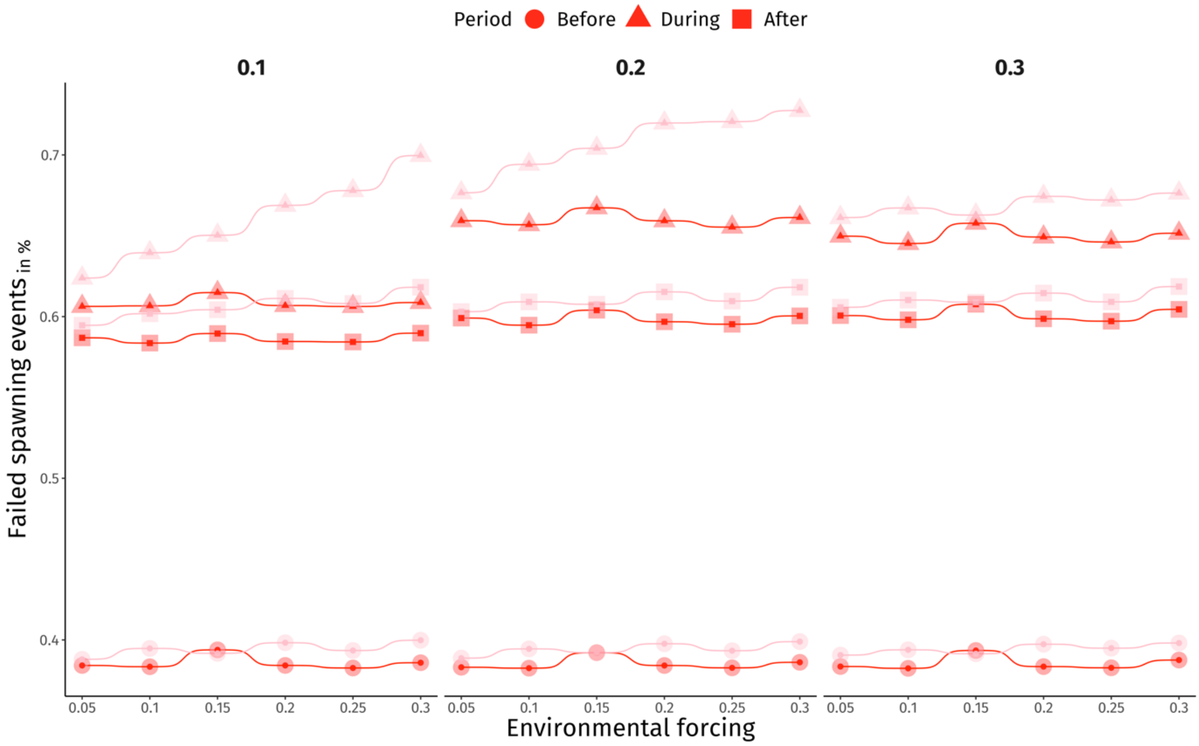

Figure S4. Proportion of failed spawning seasons among multiple (red) and single (pink) batch spawners before, during and after fishing intensity 0.10, 0.20 and 0.30 plotted against environmental forcing rate.

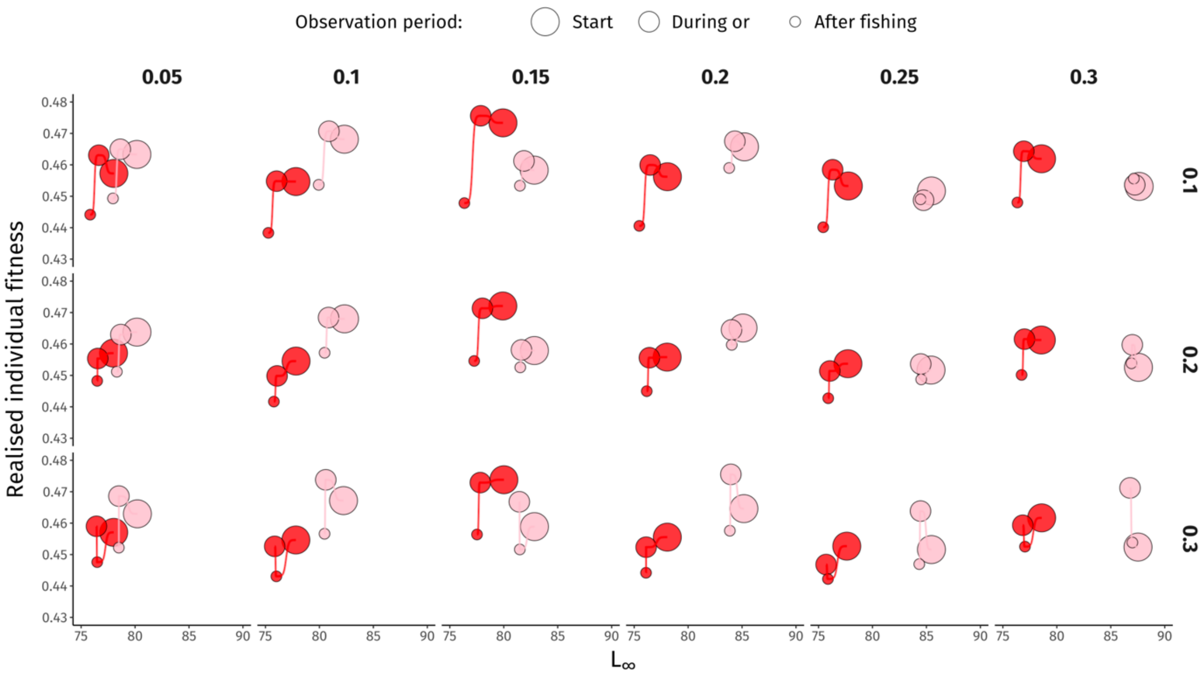

Figure S5. Average individual fitness, calculated from life-history datasets as the abundance of recruits divided by the abundance of mature adults and plotted against average asymptotic length L_∞. Multiple (red) and single (pink) batch spawning strategists are facetted for each combination of fishing (row-wise) and environmental (column-wise) pressure before, during and after fishing.

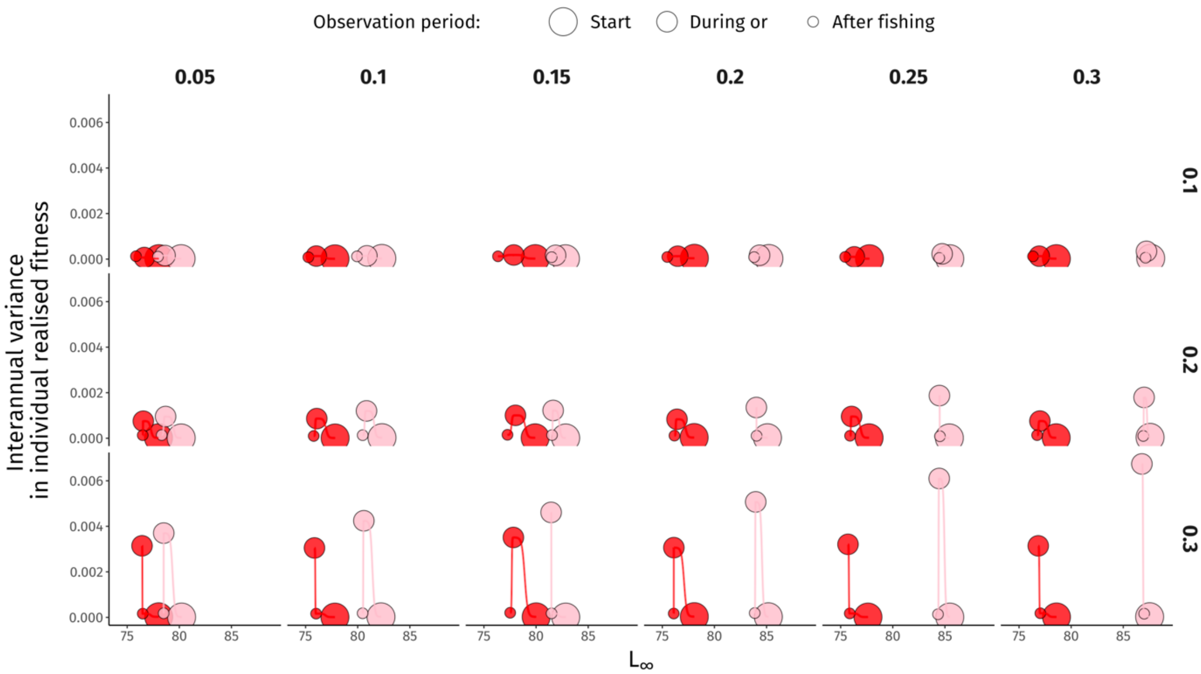

Figure S6. Average interannual variance in realised individual fitness plotted against average asymptotic length L_{∞}. The averages for each point are taken across 50 simulations. Multiple (red) and single (pink) batch spawning strategists are facetted for each combination of fishing (row-wise) and environmental (column-wise) pressure before, during and after fishing.

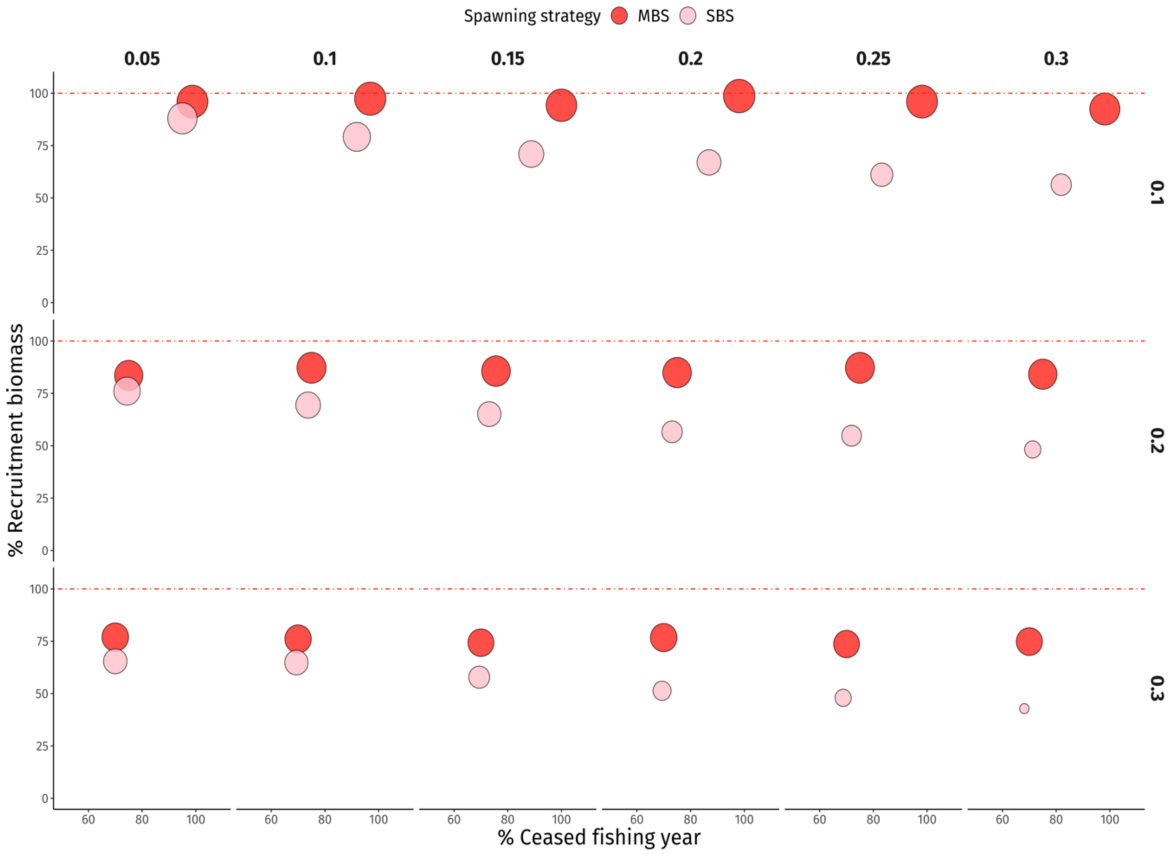

Figure S7. Onset of fishing moratorium. The percentual decrease in time and recruitment biomass when fishing was ceased is depicted by the red and pink dots for multiple and single-batch spawners, respectively. The percentages are calibrated relative to the scenario with the longest fishing period (60 years: recorded for multiple batch spawners under lowest fishing mortality) and highest recruits' biomass at the time of ceased fishing activity (166 tonnes: recorded for multiple batch spawners under lowest fishing mortality). The panels indicate fishing effort row-wise and environmental forcing applied to populations throughout the entire simulation column-wise.

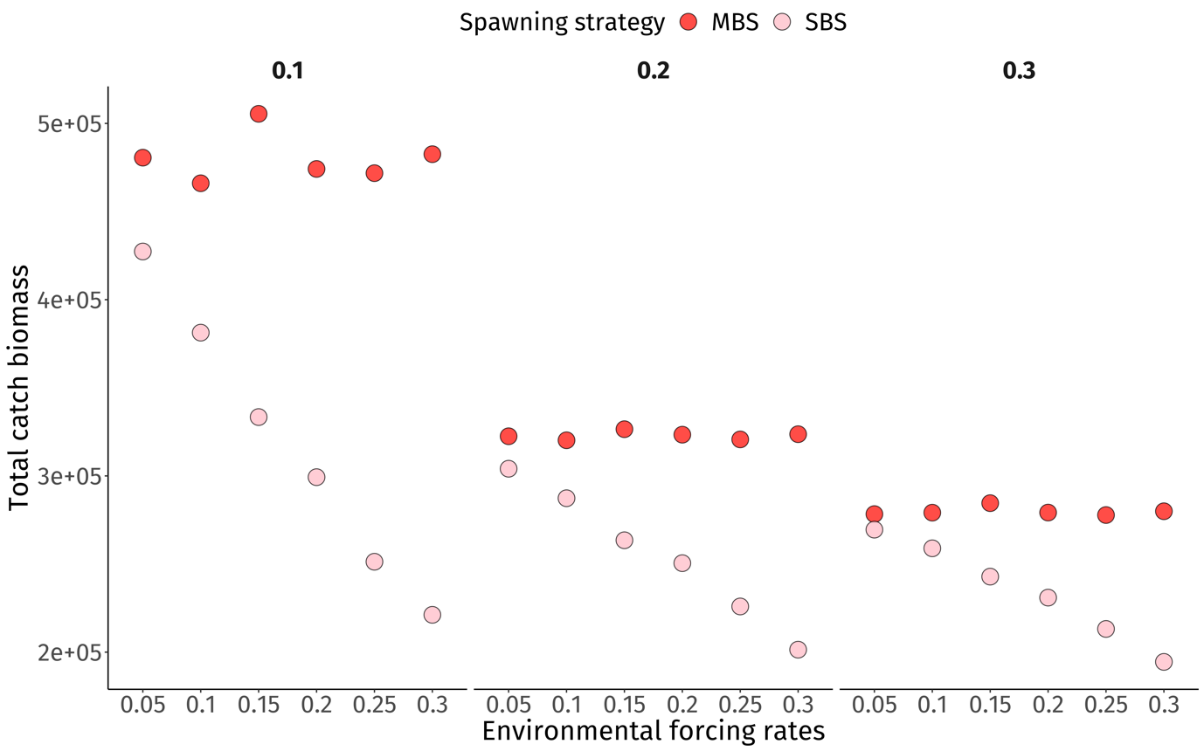

Figure S8. Total catch biomass plotted against average environmental forcing rates. The averages for each point are taken across 50 simulations. Total catches of multiple (MBS: red dots) and single (SBS: pink dots) batch spawning strategists caught under each fishing mortality rate (0.1, 0.2, 0.3) are illustrated across the three facets.