



Supplement of

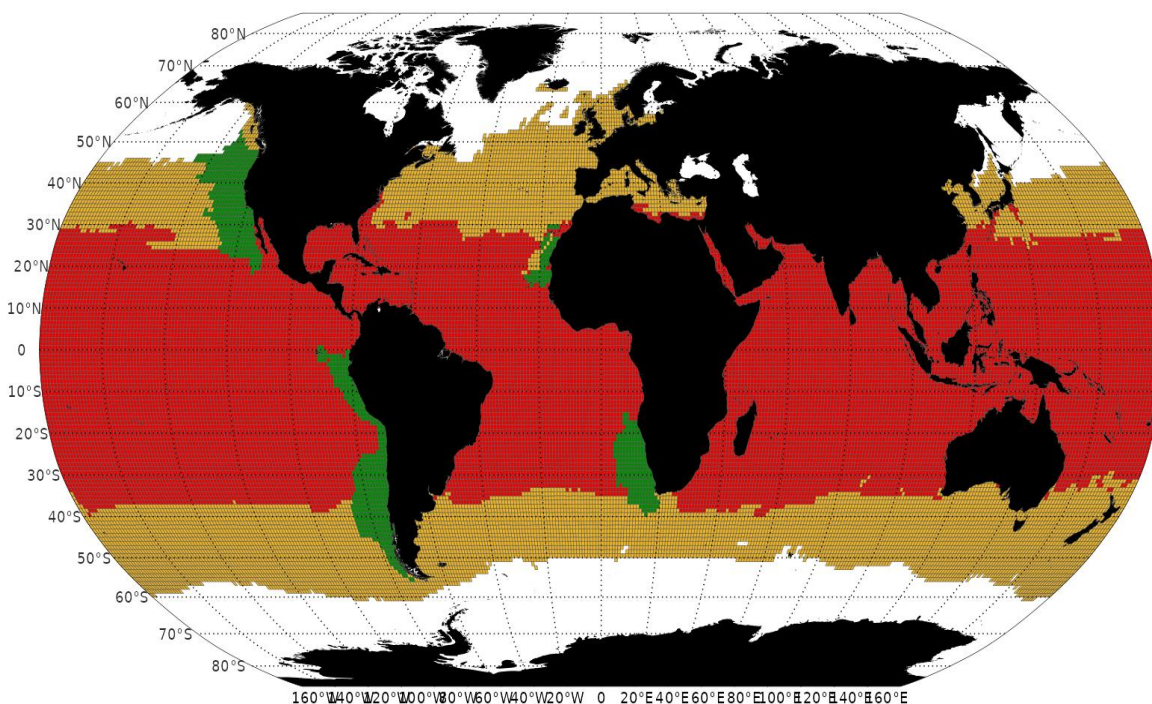
Marine heatwaves deeply alter marine food web structure and function

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S1: Study area.



6 **Figure S1: Map of where EcoTroph-Dyn was applied and the associated biome types.** The colours
 7 refer to the biome types: temperate (orange), tropical (red) and upwelling (green).
 8

S2: Time series decomposition

To create scenarios without MHWs SST time series, we decomposed the daily SST time series (Y_t) of each ocean spatial cell using a Census X-11 procedure (Vantrepotte and Mélin, 2011, Shiskin et al 1967, Pezulli et al 2005). With this method, the time series can be decomposed as:

$$Y_t = T_t + S_t + H_t$$

With Y_t the daily SST of day t , T_t the underlying long-term direction component, S_t the seasonal component (repetitive pattern over time), and H_t an irregular component, which is the unexplained variation of the time series that is not attributed to trend or seasonality.

The T_t underlying long-term direction is obtained from the annual-centered running average of the initial series Y_t . The S_t the seasonal component is then computed by applying a seasonal running mean to the trend-adjusted series ($Y_t - T_t$) to derive seasonal coefficients avoiding any confusion with the inter-annual (trend) signal. After revised estimates of these two components (Vantrepotte and Mélin, 2011, Pezulli et al 2005), the residual component is computed as

$$H_t = Y_t - S_t - T_t.$$

We applied the following procedure to create a daily SST time series for the scenarios without MHW. When the daily Y_t value was declared as an MHW day and Y_t was above the value ($T_t + S_t$), we re-assigned the daily SST value (Y_t) to the value of the daily SST without the additional variability (H_t) component i.e., $T_t + S_t$. For all the others situations (MHW day with Y_t below the threshold ($T_t + S_t$) or that the day was not an MHW day), we let the daily SST value Y_t assigned to its original value (figure S5).

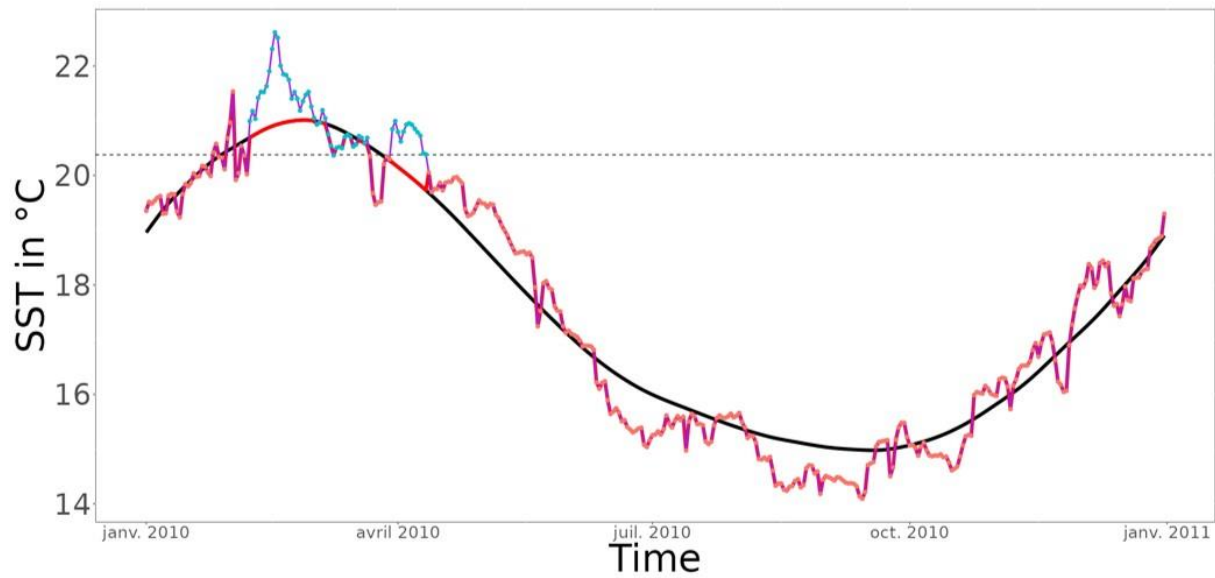


Figure S2: Illustration of the removal of MHWs from the time series. With blue and red points corresponding to MHW days and non-MHW days, respectively. The original time series of SST, represented by Y_t , is shown as a thin purple line. The time series of SST without MHW is depicted by a thick red line. The combination of the long-term linear trend and the seasonal component denoted as $T_t + S_t$, is illustrated with a thick black line. Additionally, the dotted grey line represents the fixed threshold value used for detecting MHWs in the specific ocean cell chosen for the illustration.

S3: 'Burn in' period applied to EcoTroph-Dyn model.

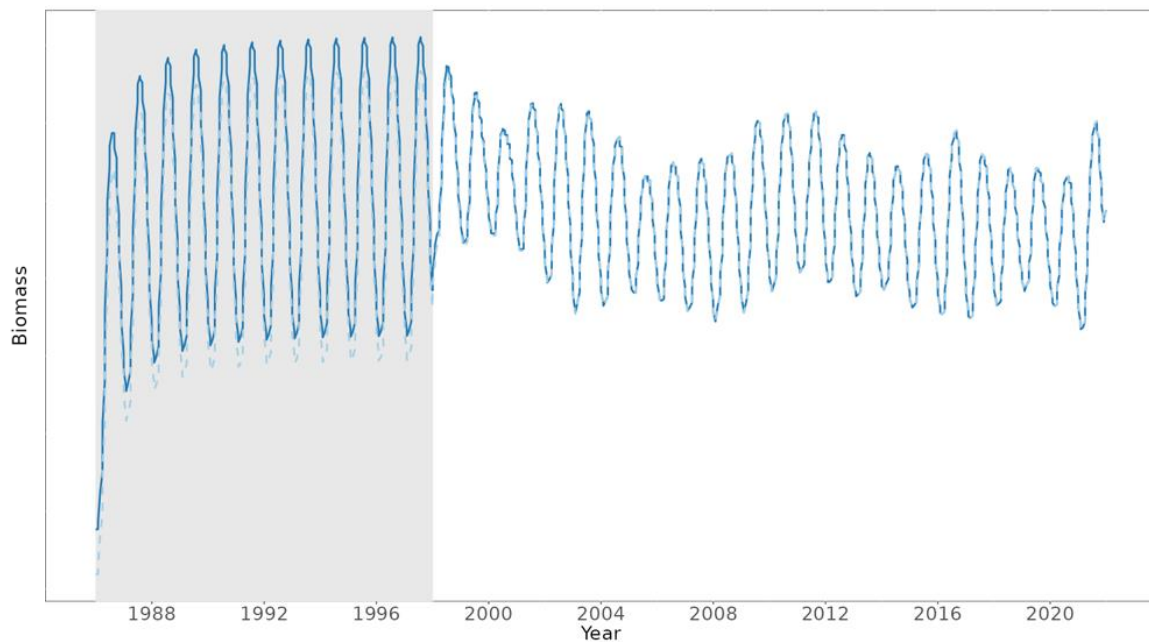


Figure S3: Illustration of the removal of MHWs from the time series. With initialisation period 1998_2021 and 1998_2006 corresponding to the darker blue solid line and lighter blue dashed line, respectively. The vertical grey shaded area indicates the 12 years of initialisation period. Afterward the hindcast analysis begins. Tests demonstrated no statistically significant differences, indicating that EcoTroph-Dyn simulations were not dependent of the initialization period onward (t.test $p_value=0.6118$).

S4: Yearly simulation masked the effects of the short-term impacts of MHWs on the long-term changes in consumer biomass

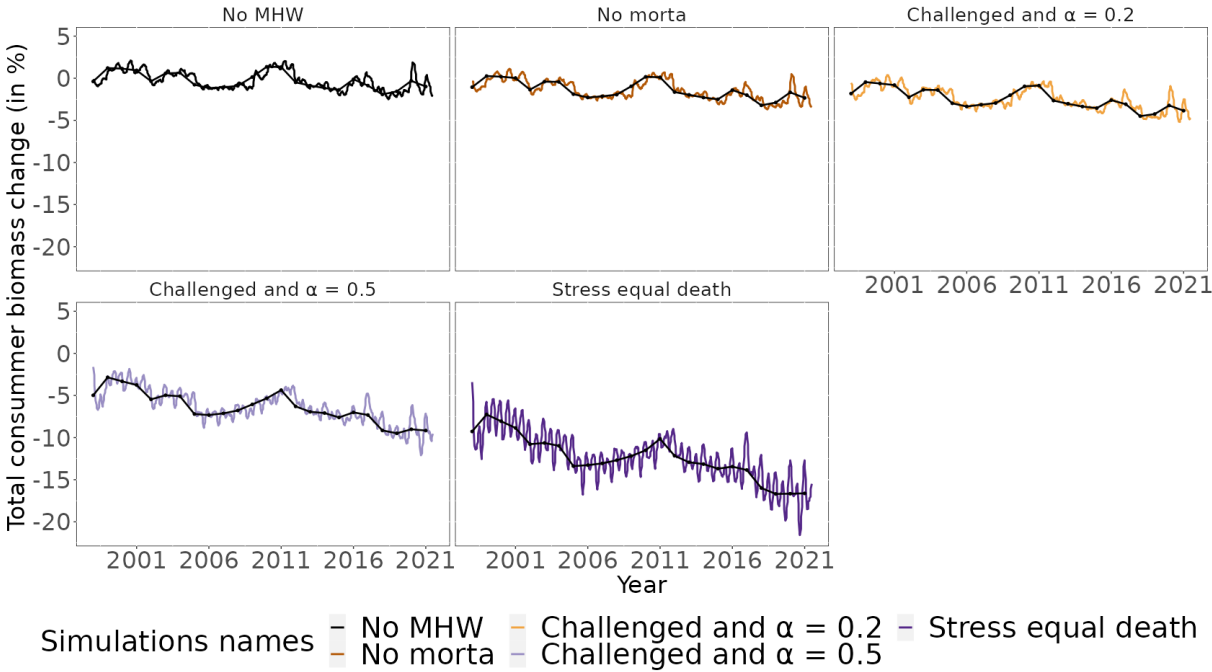
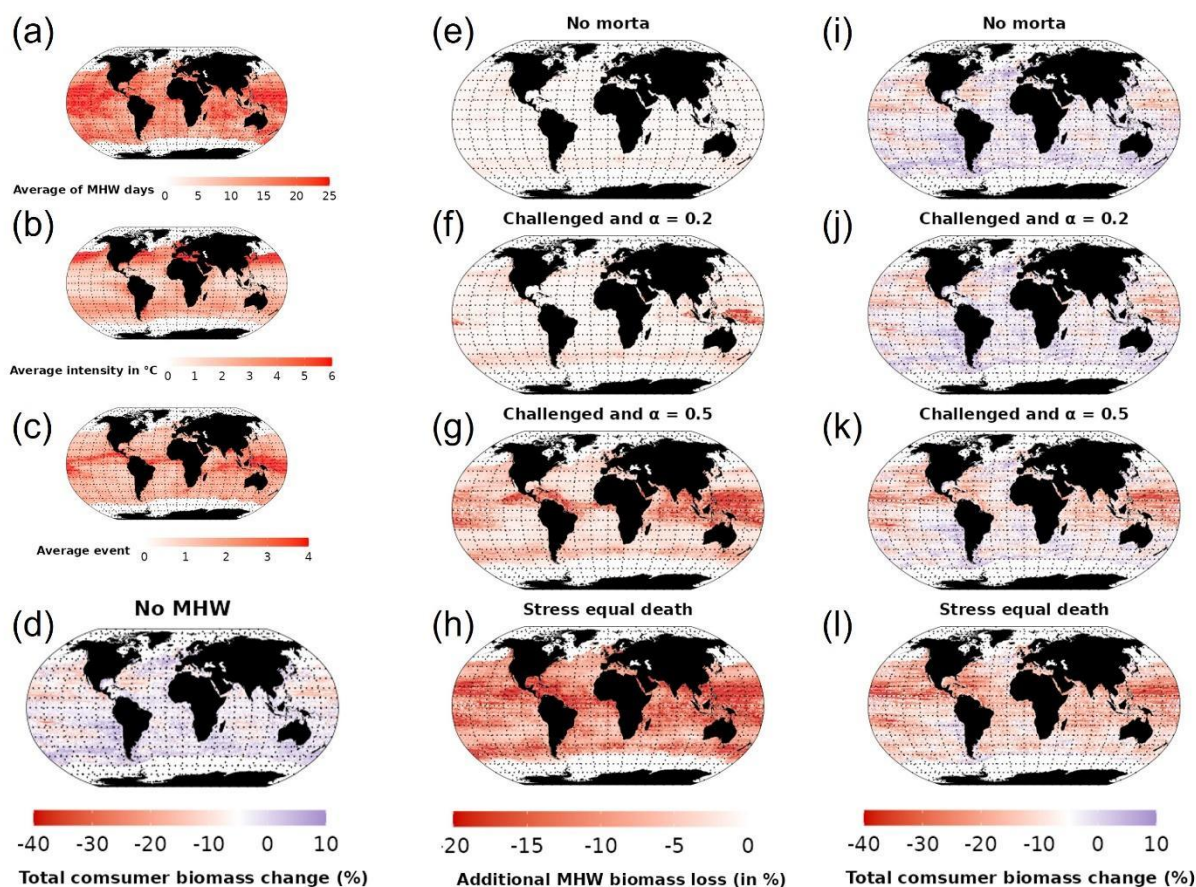


Figure S4: Yearly vs fortnight biomass evolution. With coloured lines and black lines corresponding to the fortnight and yearly biomass evolution respectively.

S5: MHWs effects on low trophic level (TLE [2;3]).



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75 **Figure S5: Additional MHW's associated biomass loss for low TL between 2015 to 2021 compared to**
 76 **1998_2009.** With (a, b, and c) maps of average MHWs days, average MHWs intensity, and average
 77 number of MHWs events between 2015 and 2021, respectively; (d) average low TL (TL between 2 and
 78 3) biomass change between 2015 and 2021 compared to 1998 to 2009 without accounting for MHWs;
 79 ((e), (f), (g), and (h)) additional low TL biomass loss associated to MHWs without additional mortality,
 80 challenged $\alpha=0.2$, challenged $\alpha=0.5$, and Stress equal death, respectively; ((i), (j), (k), and (l))
 81 corresponding of the low TL biomass change between 2015 and 2021 of these simulation compare to
 82 1998 to 2009 of No MHWs reference simulation.

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S6: MHWs effects on medium trophic level (TLE [3;4]).

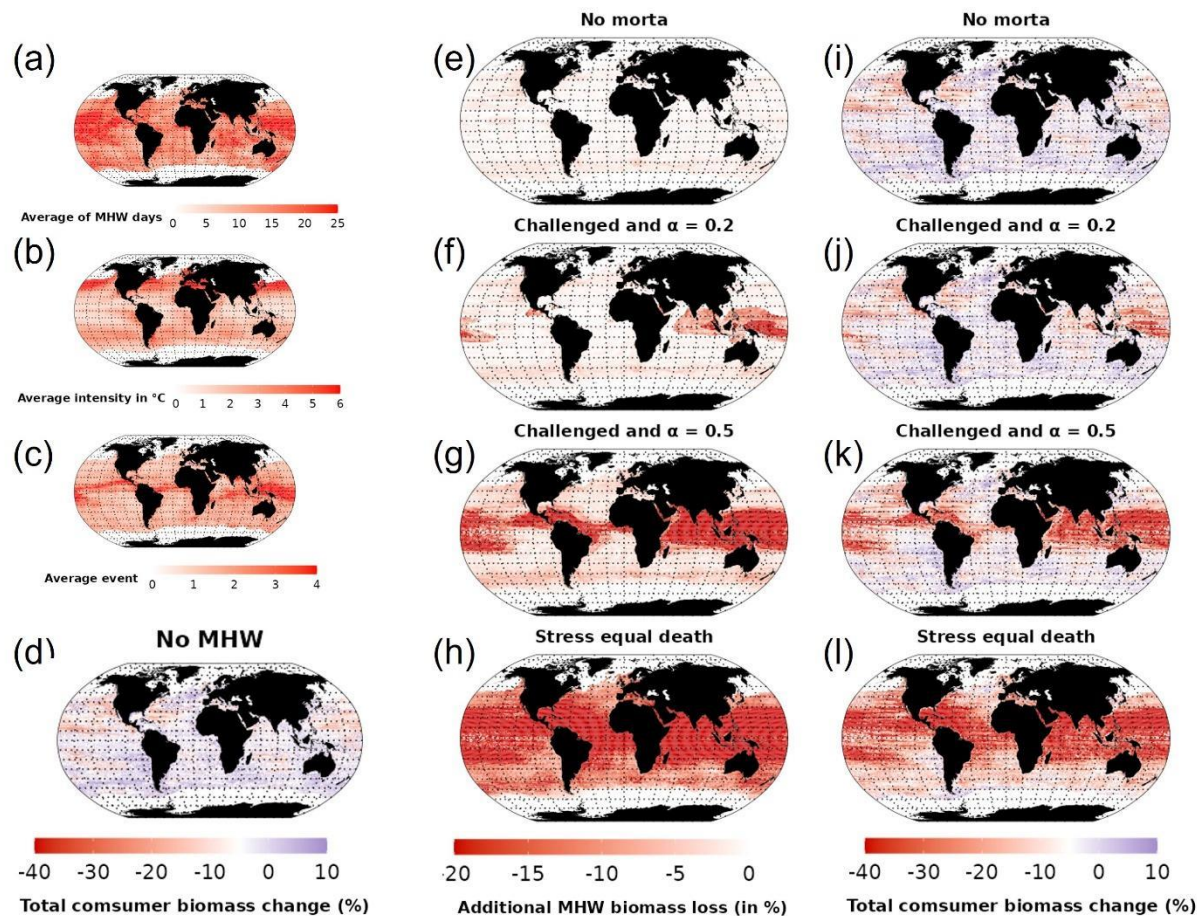
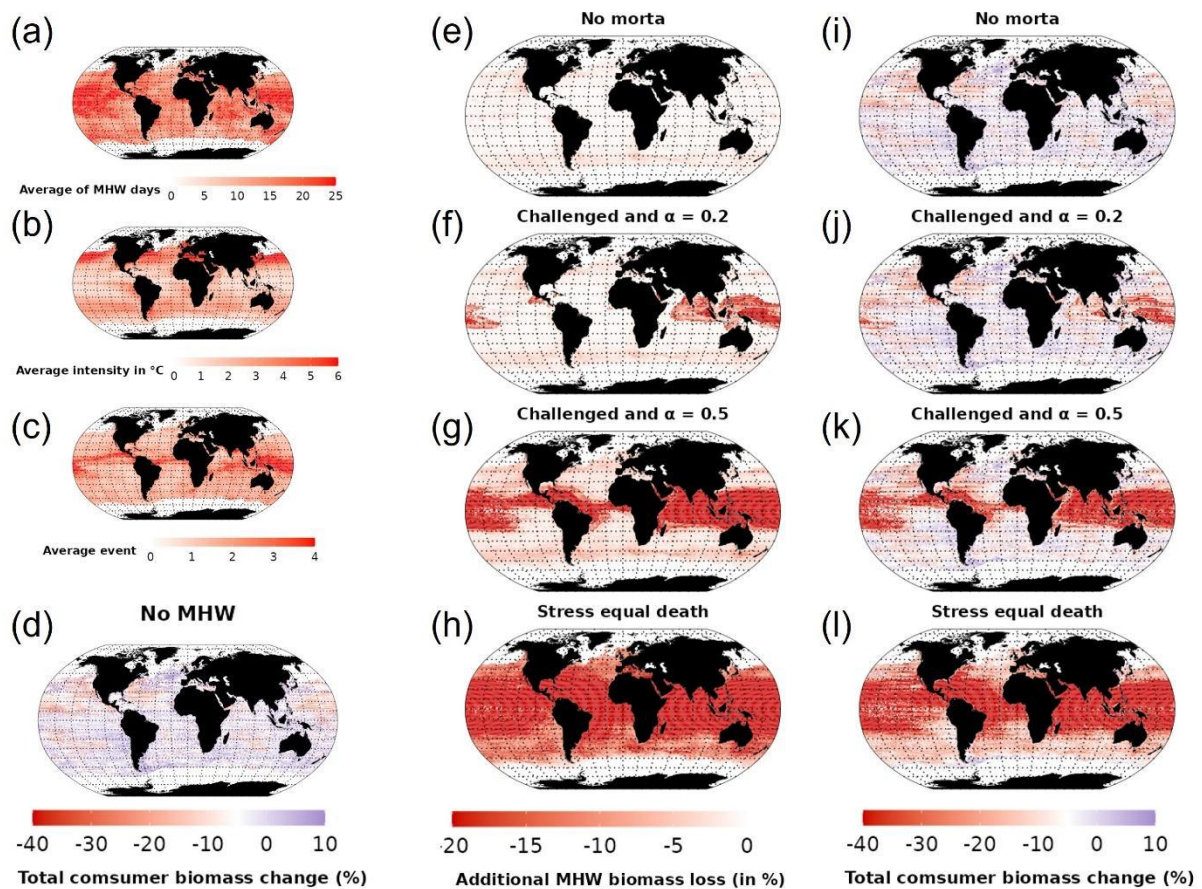


Figure S6: Additional MHW's associated biomass loss for medium TL between 2015 to 2021 compared to 1998_2009. With (a, b, and c) maps of average MHWs days, average MHWs intensity, and average number of MHWs events between 2015 and 2021, respectively; (d) average high TL (TL above 4) biomass change between 2015 and 2021 compared to 1998 to 2009 without accounting for MHWs; ((e), (f), (g), and (h)) additional high TL biomass loss associated to MHWs without additional mortality, challenged $\alpha=0.2$, challenged $\alpha=0.5$, and Stress equal death, respectively; ((i), (j), (k), and (l)) corresponding of the high TL biomass change between 2015 and 2021 of these simulation compare to 1998 to 2009 of No MHWs reference simulation.

S7: MHWs effects on high trophic level (TL= 4-5.5).



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99 **Figure S7: Additional MHW's associated biomass loss for high TL between 2015 to 2021 compared to**

100 **1998_2009.** With (a, b, and c) maps of average MHWs days, average MHWs intensity, and average
 101 number of MHWs events between 2015 and 2021, respectively; (d) average medium TL (TL between 3
 102 and 4) biomass change between 2015 and 2021 compared to 1998 to 2009 without accounting for
 103 MHWs; ((e), (f), (g), and (h)) additional medium TL biomass loss associated to MHWs without additional
 104 mortality, challenged $\alpha=0.2$, challenged $\alpha=0.5$, and Stress equal death, respectively; ((i), (j), (k), and (l))
 105 corresponding of the medium TL biomass change between 2015 and 2021 of these simulation compare
 106 to 1998 to 2009 of No MHWs reference simulation.

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S8: Food-web response to ‘the Blob’ MHW.

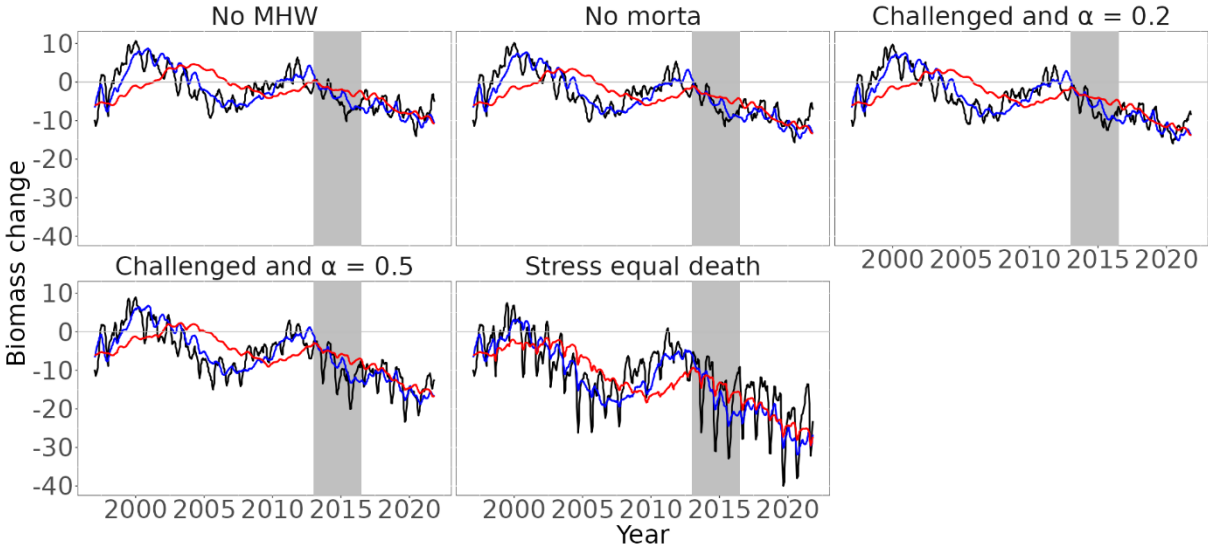
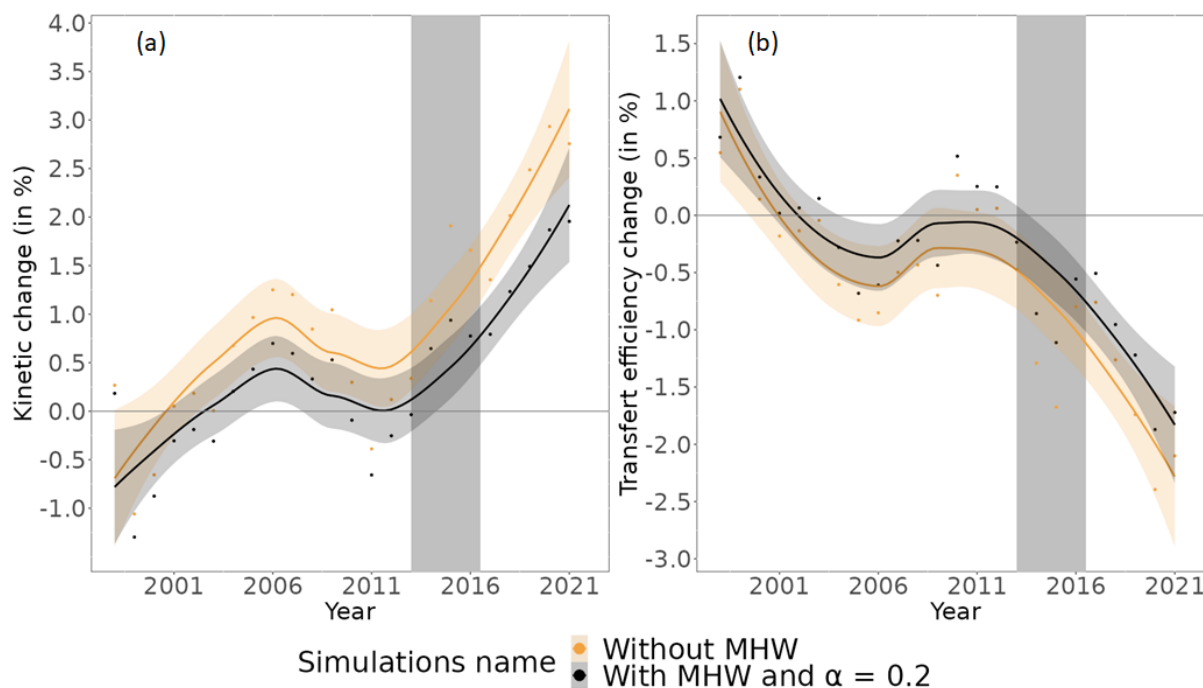


Figure S8: Blob-associated biomass loss over food web compartment compared to “without MHW” simulation 1998_2009 reference period. With low TL (trophic level $\in [2; 3[$), medium TL (trophic level $\in [3; 4[$), and high TL (trophic level ≥ 4) responses to MHWs corresponding to black, blue, and red lines, respectively.

S9: Biomass flow response to ‘the Blob’ MHW.



126 **Figure S9: Hindcast changes in biomass flow processes (i.e. trophodynamic parameters) in the**
 127 **Northeast Pacific between 1998 and 2021 relative to 1998-2009 “Without MHW” reference. (a)**
 128 **Changes in flow kinetic. (b) transfer efficiency changes. The shaded areas around the curves represent**
 129 **the standard error. Without MHW and with MHWs scenarios correspond to the black and light orange**
 130 **colour**