Marine heatwaves are not a dominant driver of change in fish communities

Supplementary Information

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Contents

1 Supplementary tables

Supplementary Table 1: Survey names used in this analysis, and corresponding abbreviations used in figures and tables in this Supplement. The survey codes from FISHGLOB are also listed for comparison to other data from the FISHGLOB Consortium.

FISHGLOB Code	Survey	Abbreviation
BITS	Baltic Sea	BalS
DFO-QCS	British Columbia	BC
EBS	Eastern Bering Sea	EBS
EVHOE	France	FR
FR-CGFS	English Channel	EC
GMEX	Gulf of Mexico	GoM
GOA	Gulf of Alaska	GoA
GSL-S	Gulf of Saint Lawrence	GSL
IE-IGFS	Ireland	IR
NEUS	Northeast US	NeUS
NIGFS	Northern Ireland	NI
Nor-BTS	Barents Sea	BarS
NS-IBTS	North Sea	NS
PT-IBTS	Portugal	PO
SCS	Scotian Shelf	SS
SEUS	Southeast US	SeUS
SWC-IBTS	Scotland	SC
WCANN	West Coast US	WUS

Supplementary Table 2: Models of biomass response to MHWs. All models were fitted to biomass log ratio values (scaled and centered within surveys) using MHW cumulative intensity in °C-days as a predictor (scaled and centered within surveys, calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text). Model names correspond to: null (intercept-only) model, linear model, linear model including survey as a fixed effect, generalized additive model (GAM), and GAM including survey as a random effect.

	Null	LM	LM Survey	GAM	GAM Survey
Intercept	0.00 ± 0.051	0.00 ± 0.052	0.00 ± 0.236	0.00 ± 0.051	0.00 ± 0.051
MHW coefficient	NA	0.008 ± 0.053	0.008 ± 02	NA	NA
Coefficient p-value	NA	0.88	0.883	0.593	0.593
R^2	NA	0.000	0.000	0.004	0.004
AIC	1007	1009	1043	1009	1009
Degrees of freedom	359	358	341	356	356

Supplementary Table 3: Linear models of biomass response to MHWs in each individual region. All models were fitted to biomass log ratio values (scaled and centered within surveys) using MHW cumulative intensity in °C-days as a predictor (scaled and centered within surveys, calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text).

	Intercept	MHW coefficient	Coefficient p-value	R^2	AIC	Degrees of freedom
Baltic Sea	0.00 ± 0.243	-0.012 ± 0.25	0.962	0.00	56	16
British Columbia	0.00 ± 0.338	0.316 ± 0.359	0.408	0.10	30	7
Eastern Bering Sea	0.00 ± 0.187	-0.358 ± 0.191	0.073	0.128	75	24
France	0.00 ± 0.221	0.164 ± 0.226	0.478	0.027	64	19
English Channel	0.00 ± 0.221	0.15 ± 0.227	0.516	0.022	64	19
Gulf of Mexico	0.00 ± 0.192	-0.287 ± 0.196	0.155	0.082	77	24
Gulf of Alaska	0.00 ± 0.283	-0.535 ± 0.299	0.111	0.286	30	8
Gulf of Saint Lawrence	0.00 ± 0.193	0.332 ± 0.197	0.105	0.11	73	23
Ireland	0.00 ± 0.258	-0.059 ± 0.267	0.828	0.003	50	14
Northeast US	0.00 ± 0.187	0.352 ± 0.191	0.078	0.124	75	24
Northern Ireland	0.00 ± 0.335	-0.02 ± 0.353	0.957	0.00	33	8
Barents Sea	0.00 ± 0.209	0.015 ± 0.213	0.944	0.00	73	22
North Sea	0.00 ± 0.20	-0.066 ± 0.204	0.75	0.004	79	24
Portugal	0.00 ± 0.299	-0.342 ± 0.313	0.303	0.117	35	9
Scotian Shelf	0.00 ± 0.209	0.009 ± 0.213	0.968	0.00	73	22
Southeast US	0.00 ± 0.20	-0.011 ± 0.204	0.956	0.00	79	24
Scotland	0.00 ± 0.20	0.076 ± 0.204	0.712	0.006	79	24
West Coast US	0.00 ± 0.264	0.163 ± 0.274	0.562	0.027	47	13

Supplementary Table 4: Models of biomass response to MHWs. This table is identical to Supp. Tab. 2, except rather than centering and scaling MHW cumulative intensity within regions, it is centered and scaled across regions. The approach used in most of these models (centering and scaling MHW cumulative intensity within regions) assumes that history matters in ecological responses to MHW responses, i.e., that biomass change should be compared to how anomalous a MHW is relative to other MHWs that occurred in the region. Here, we test the hypothesis that absolute MHW cumulative intensity matters regardless of the oceanographic history of each region (centering and scaling MHW cumulative intensity across regions). All models were fitted to biomass log ratio values (scaled and centered within surveys) using MHW cumulative intensity in days (scaled and centered within surveys, calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text). Model names correspond to: null (intercept-only) model, linear model, linear model including survey as a fixed effect, generalized additive model (GAM), and GAM including survey as a random effect.

	Null	LM	LM Survey	GAM	GAM Survey
Intercept	0.00 ± 0.051	0.00 ± 0.052	0.002 ± 0.236	0.00 ± 0.051	0.00 ± 0.051
MHW coefficient	NA	0.009 ± 0.052	0.009 ± 02	NA	NA
Coefficient p-value	NA	0.867	0.865	0.185	0.18
R^2	NA	0.000	0.000	0.019	0.019
AIC	1007	1009	1043	1008	1008
Degrees of freedom	359	358	341	352	352

Supplementary Table 5: Models of biomass response to lagged MHW effects. These are generalized additive models (GAMs) that use a smoothed predictor matrix containing lagged MHW data for up to five years into the past. Results from the GAM for 0-1 years in the past, i.e., the twelve months preceding a survey, can be found in Supp. Tab. 2. All models were fitted to biomass log ratio values (scaled and centered within surveys) using MHW cumulative intensity in °C-days (scaled and centered within surveys, calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text).

	1-2 Years	1-3 Years	1-4 Years	1-5 Years
p-value	0.531	0.552	0.164	0.559
R^2	-0.002	0.001	0.003	-0.002
AIC	955	902	841	797
Degrees of freedom	340	321	304	286

Supplementary Table 6: Null (intercept-only) model and generalized linear model (GLM) of biomass as a function of MHWs and biomass from the previous time step. This Gompertz model accounts for autoregressive properties of the biomass time-series and tests whether the magnitude of biomass in any given year affected the log ratio of biomass (i.e., our metric of biomass change) in the following year. It predicts biomass log ratios with MHW cumulative intensity in °C-days (scaled and centered within surveys, calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text) and biomass from the previous survey in that region (log-transformed, but not a log ratio, and not scaled and centered). Rather than centering and scaling, to account for variability and heteroskedasticity among surveys, we included survey identity as a fixed effect and allowed dispersion to vary among surveys.

	Null model	Gompertz GLM
Intercept	0.01 $\pm$ 0.013	0.317 $\pm$ 0.241
MHW coefficient	NA	-0.009 $\pm$ 0.012
Coefficient p-value	NA	0.444
R^2	NA	0.335
AIC	180	99
Degrees of freedom	341	287

Supplementary Table 7: Null model (latitude-only) and model of biomass response to MHWs, latitude, and their interaction. Linear model was fitted to biomass log ratio values (scaled and centered within surveys) using MHW cumulative intensity in °C-days (scaled and centered within surveys, calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text) and median latitude of each survey (scaled and centered across surveys) as predictors.

	Null model	Linear model
Intercept	0.00 ± 0.052	0.00 ± 0.052
MHW coefficient	NA	0.008 ± 0.053
Latitude coefficient	0.00 ± 0.052	0.00 ± 0.052
Interaction coefficient	NA	-0.006 ± 0.053
MHW coefficient p-value	NA	0.88
Latitude p-value	1.00	1.00
Interaction p-value	NA	0.909
R^2	0.00	0.00
AIC	1009	1013
Degrees of freedom	358	356

Supplementary Table 8: Null (intercept-only) model and model of depth response to MHWs. Linear model was fitted to the weighted mean depth of the fish assemblage every year (scaled and centered within surveys) using MHW cumulative intensity in °C-days as a predictor (scaled and centered within surveys, calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text).

	Null model	Linear model
Intercept	0.00 ± 0.053	0.00 ± 0.053
MHW coefficient	NA	-0.016 ± 0.055
Coefficient p-value	NA	0.775
R^2	NA	0.00
AIC	937	939
Degrees of freedom	334	333

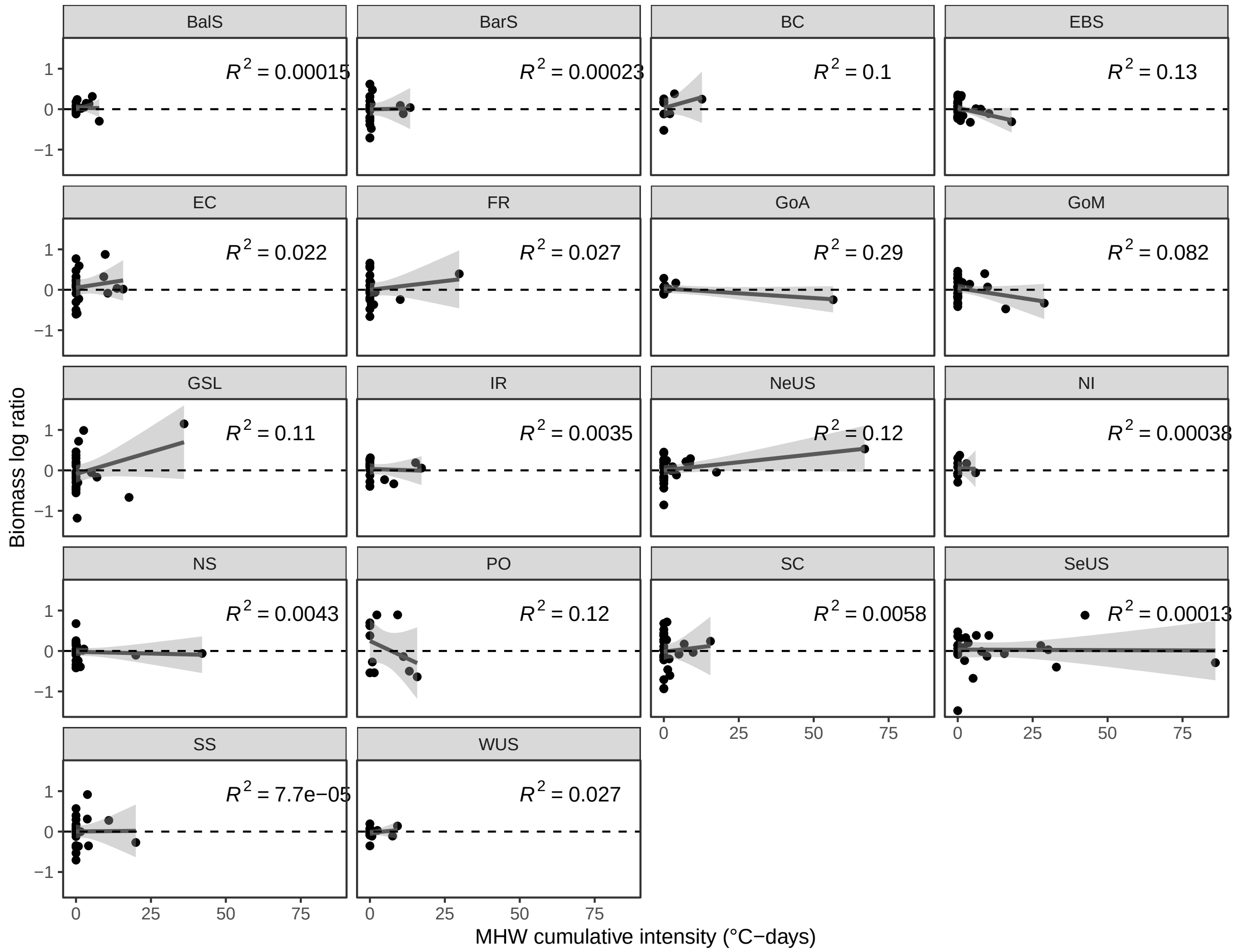
Supplementary Table 9: Null model (catch-only) and model of biomass response to MHWs, catch, and their interaction. We matched survey footprints to Marine Ecoregions (MEs) and extracted catch data from the Sea Around Us database (see Methods). Surveys from the English Channel and France did not correspond well to ME boundaries and were omitted. Because catch was available by calendar year and surveys occur midyear, we compared biomass change to the mean of the last three years of catch (i.e., biomass change in a 2010 survey was predicted by mean catch in 2008, 2009, and 2010), scaled and centered within surveys. Biomass log ratio values were also scaled and centered within surveys. This linear model used MHW cumulative intensity in °C-days (scaled and centered within surveys, calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text).

	Null model	Linear model
Intercept	-0.018 ± 0.056	-0.019 ± 0.056
MHW coefficient	NA	-0.02 ± 0.057
Catch coefficient	-0.039 ± 0.061	-0.041 ± 0.061
Interaction coefficient	NA	-0.04 ± 0.063
MHW coefficient p-value	NA	0.732
Catch coefficient p-value	0.527	0.503
Interaction p-value	NA	0.528
R^2	0.001	0.003
AIC	864	868
Degrees of freedom	309	307

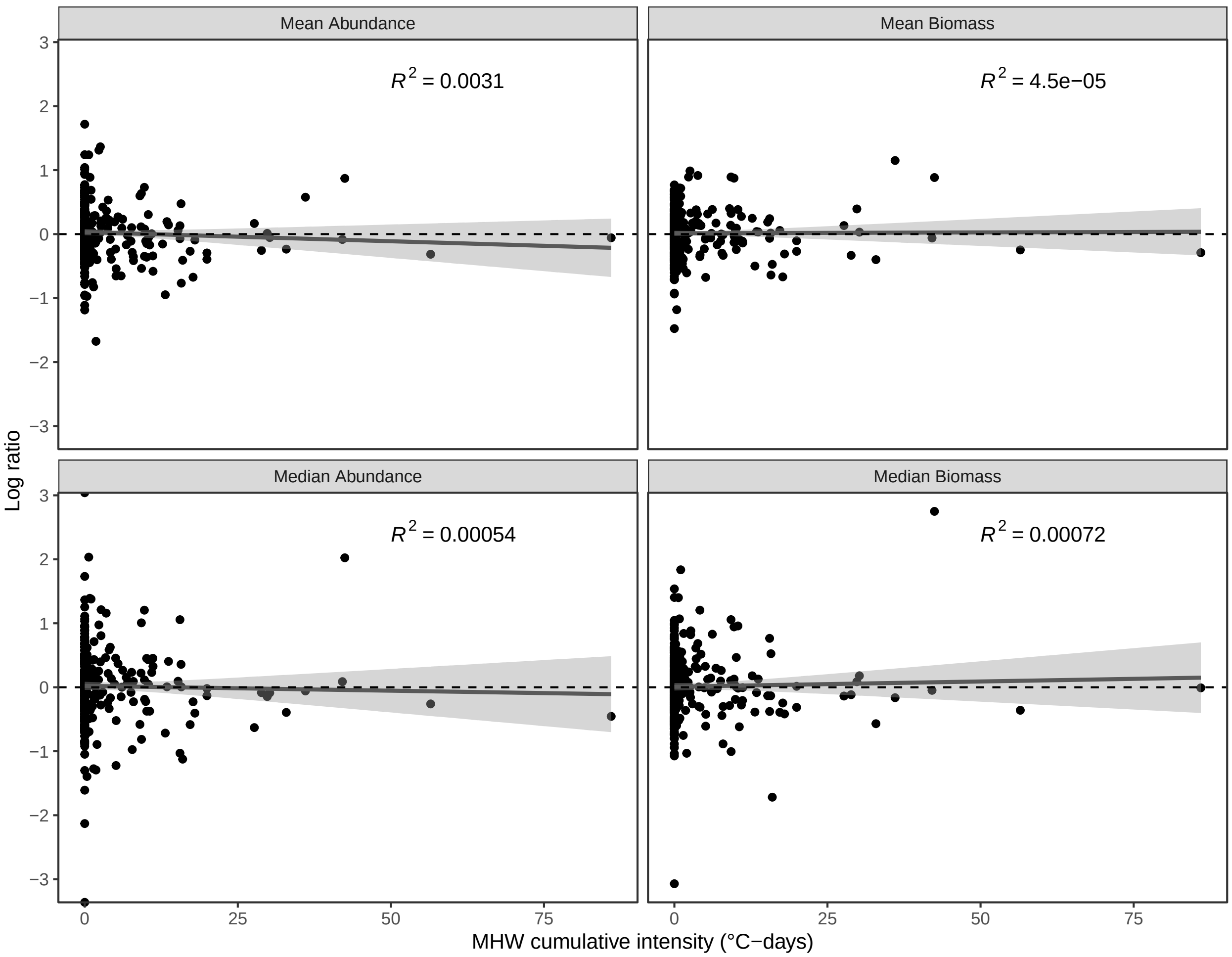
Supplementary Table 10: Models of Community Temperature Index (CTI) response to MHWs. All models were fitted to CTI year-over-year difference values (scaled and centered within surveys) using MHW cumulative intensity in °C-days as a predictor (scaled and centered within surveys, calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text). Model names correspond to: null (intercept-only) model, linear model, linear model including survey as a fixed effect, generalized additive model (GAM), and GAM including survey as a random effect.

	Null	LM	LM Survey	GAM	GAM Survey
Intercept	0.00 ± 0.051	0.00 ± 0.051	0.00 ± 0.236	0.00 ± 0.051	0.00 ± 0.051
MHW coefficient	NA	0.051 ± 0.053	0.051 ± 02	NA	NA
Coefficient p-value	NA	0.332	0.344	0.311	0.311
R^2	NA	0.003	0.003	0.004	0.004
AIC	1007.170	1008.223	1042.223	1007.244	1007.244
Degrees of freedom	359.000	358.000	341.000	357.311	357.311

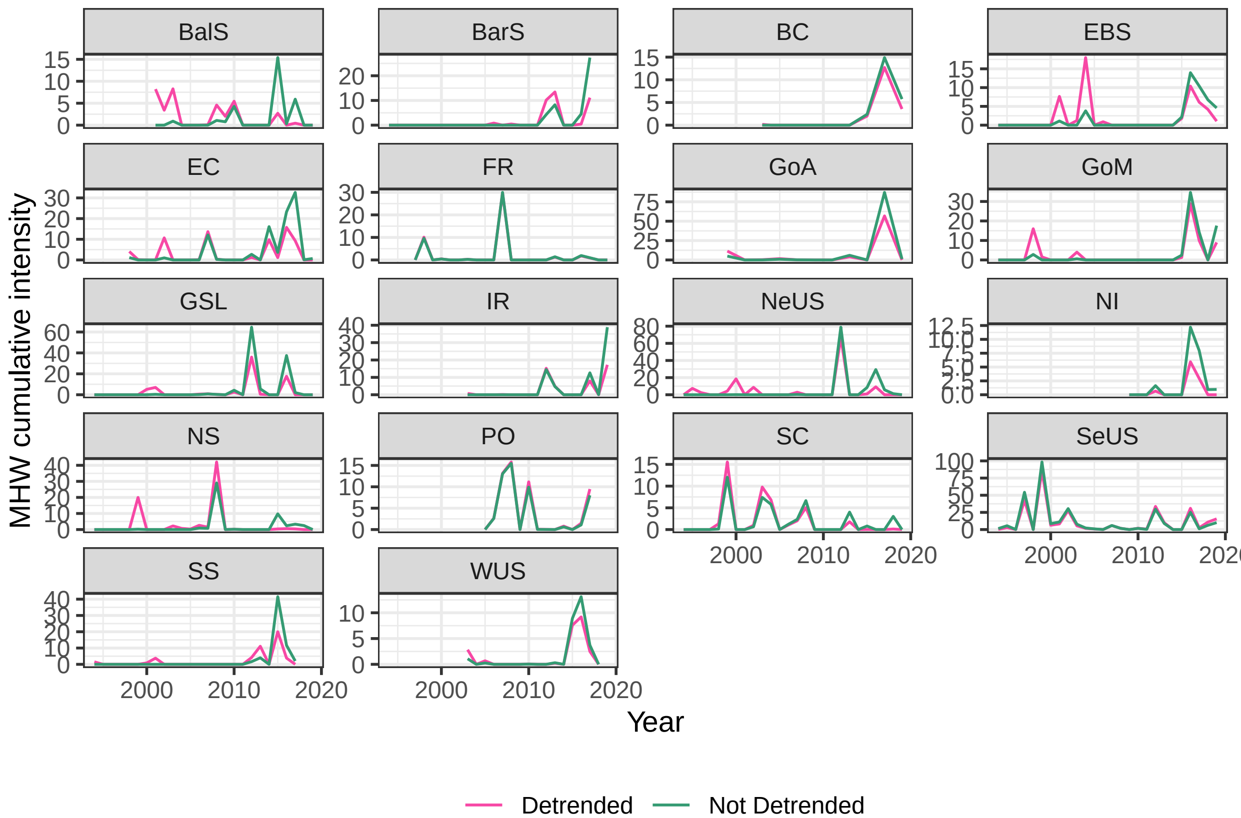
2 Supplementary figures: sensitivity of main results to metrics and methods



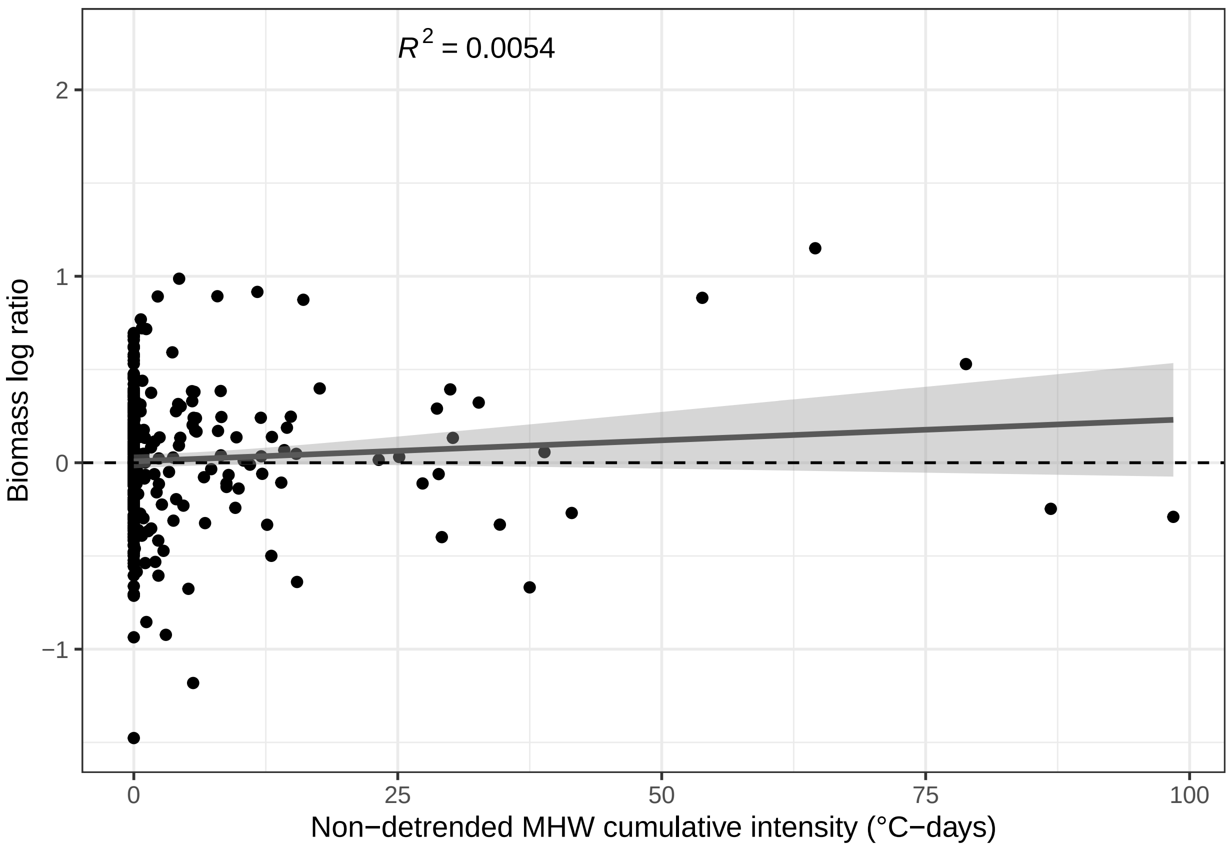
Supplementary Figure 1: Alternate version of Fig. 2 from the main text, showing results by region. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. Points represent log ratios of mean biomass in a survey from one year to the next. The fitted lines are linear regressions. The shaded areas are 95% confidence intervals. Survey names are listed in Supp. Tab. 1.



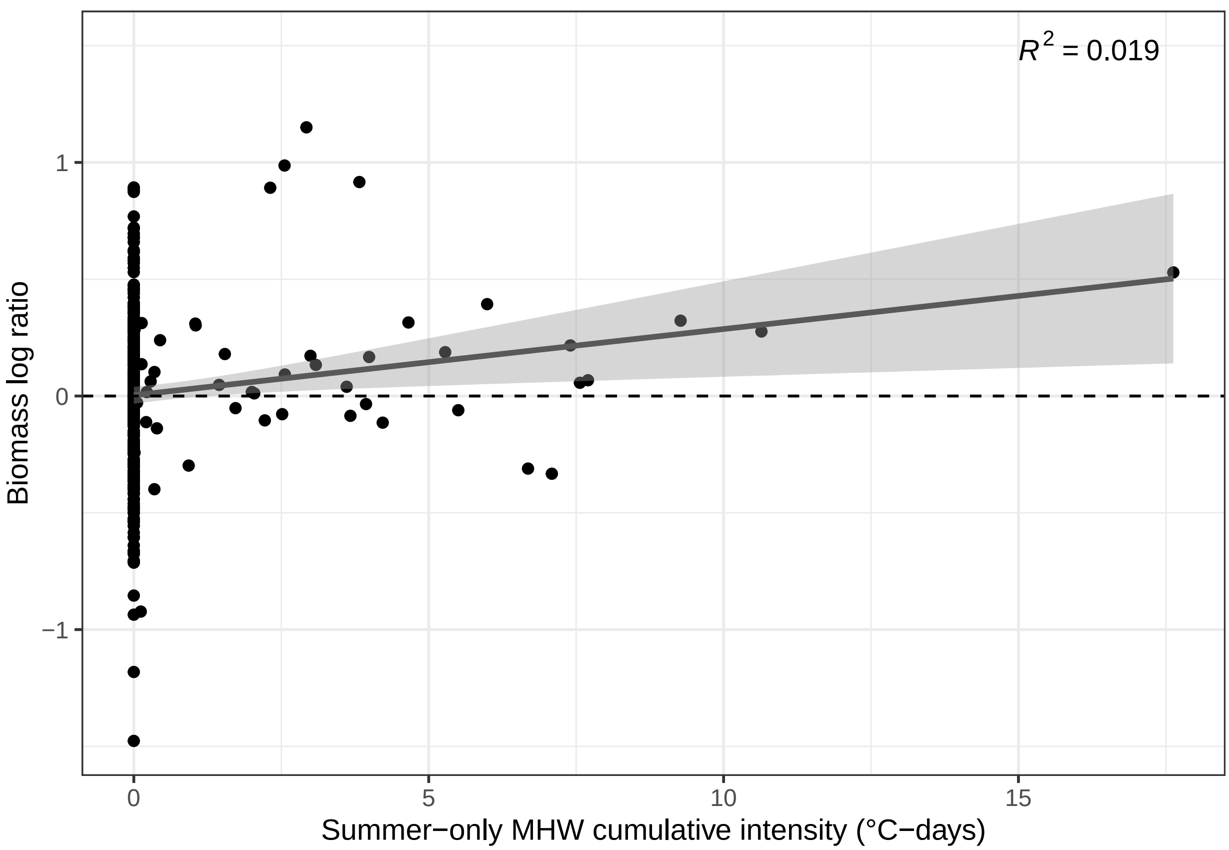
Supplementary Figure 2: Alternate version of Fig. 2 from the main text using different metrics of biomass change: mean abundance, mean biomass (used in the main text), median abundance, and median biomass. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. Points represent log ratios of each metric in a survey from one year to the next. The fitted lines are linear regressions. The shaded areas are 95% confidence intervals. The Northeast US survey was omitted because it did not have abundance data recorded.



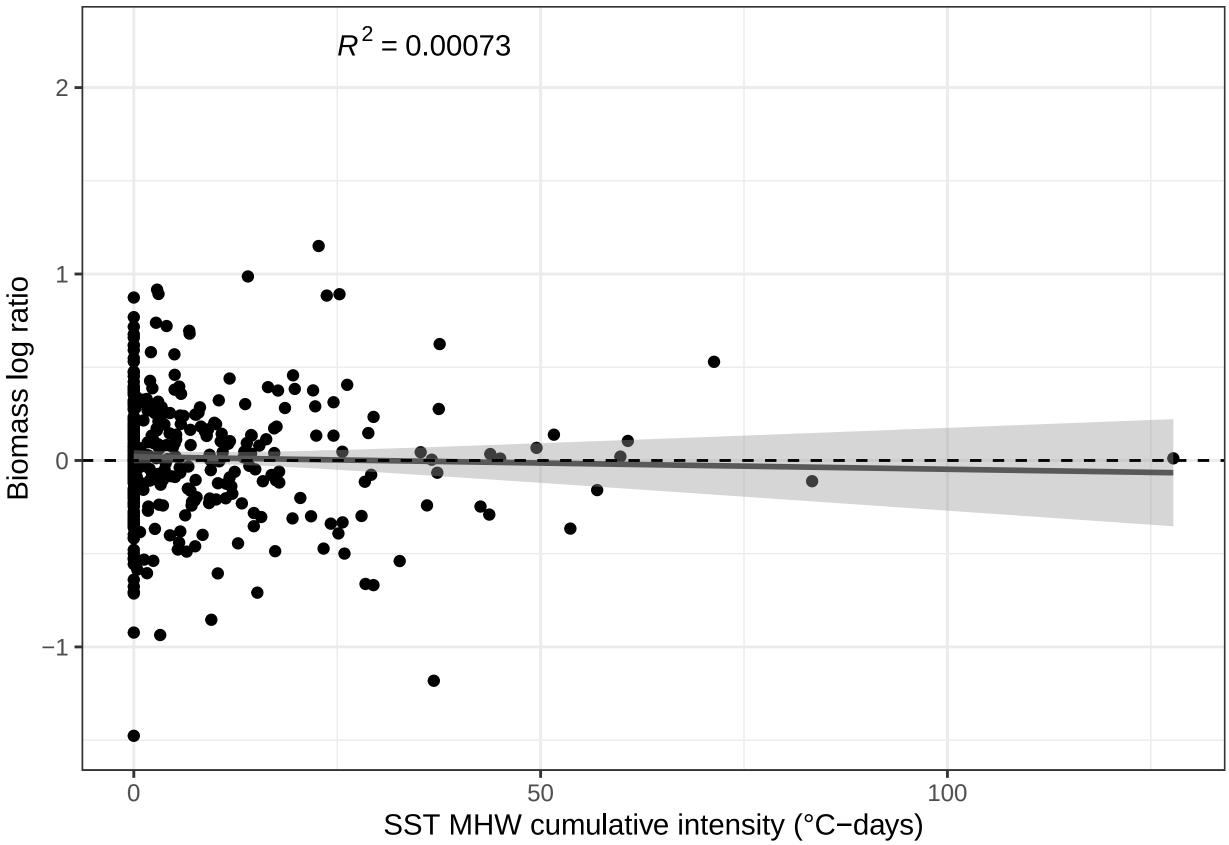
Supplementary Figure 3: MHW cumulative intensity (total anomaly in °C-days) in each survey region with and without detrending the temperature data to remove the signal of secular warming. The main text results are detrended. Here, we plot MHW cumulative intensity based on all SBT anomalies from GLORYS, rather than applying the five-day threshold that was used the main text, to more clearly show the differences between the two methods.



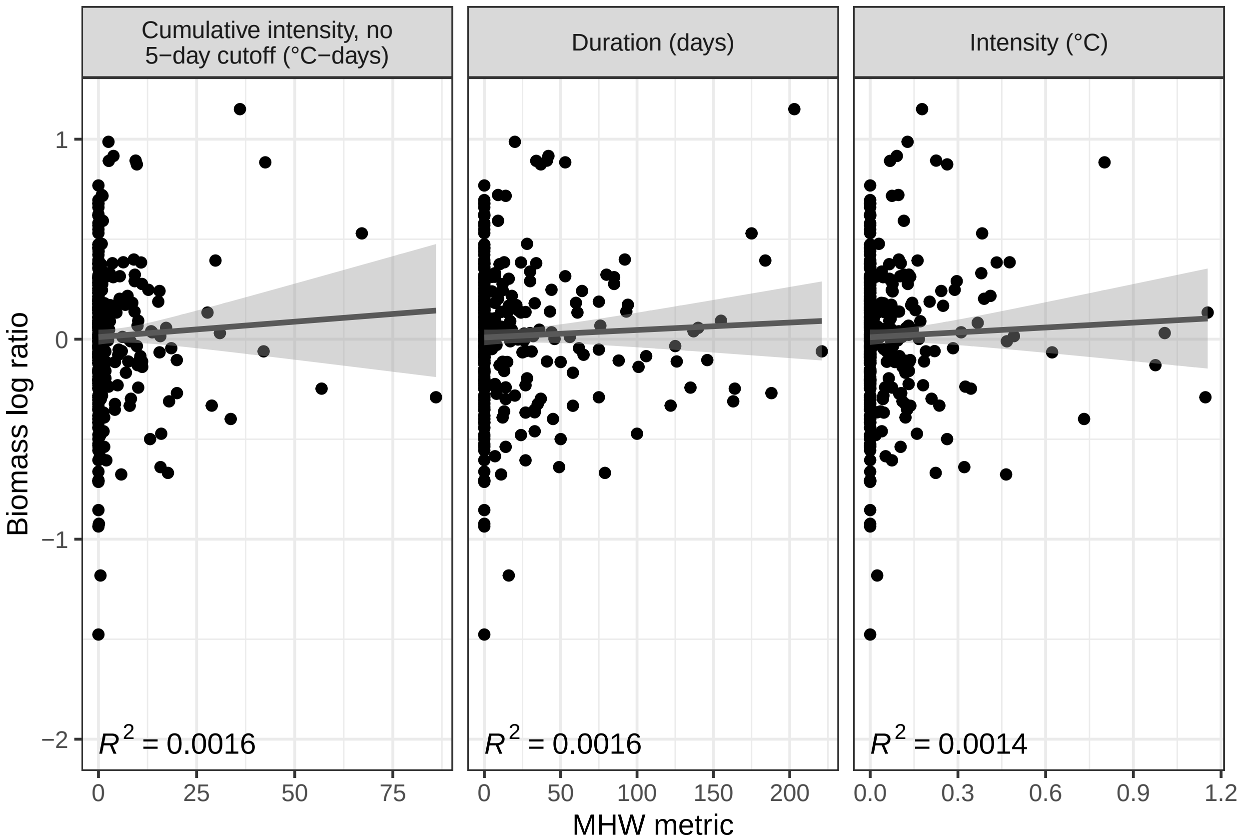
Supplementary Figure 4: Alternate version of Fig. 2 from the main text, showing biomass change (log ratio) and MHW cumulative intensity (total anomaly in °C-days, using GLORYS data with the five-day MHW threshold) calculated from non-detrended data. The fitted lines are linear regressions. The shaded areas are 95% confidence intervals.



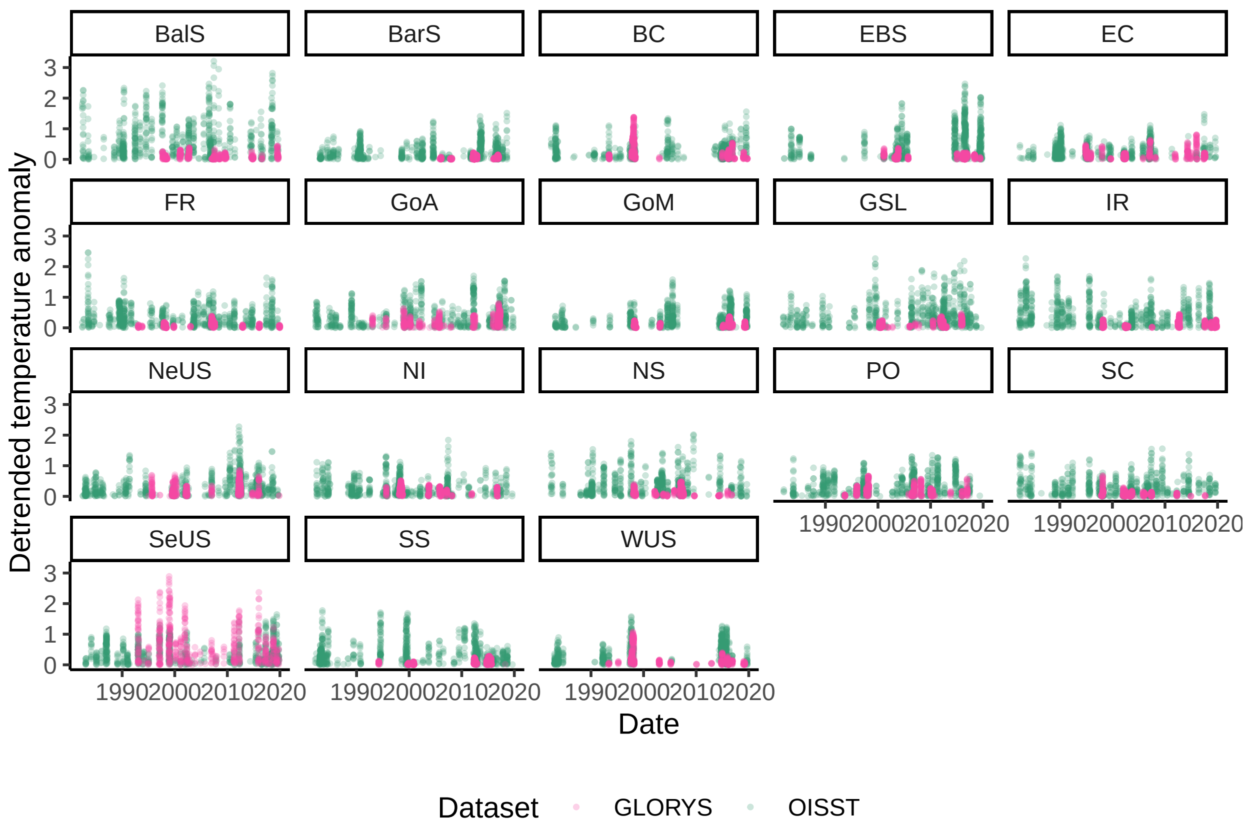
Supplementary Figure 5: Alternate version of Fig. 2 from the main text, showing biomass change (log ratio) and MHW cumulative intensity (total anomaly in °C-days, using GLORYS data without the five-day MHW threshold) based on only summer temperature anomalies (June, July, and August in the Northern Hemisphere). The fitted lines are linear regressions. The shaded areas are 95% confidence intervals.



Supplementary Figure 6: Alternate version of Fig. 2 from the main text, showing biomass change (log ratio) and MHW cumulative intensity (total anomaly in °C-days, using detrended OISST sea surface temperature data with the five-day MHW threshold). The fitted lines are linear regressions. The shaded areas are 95% confidence intervals.

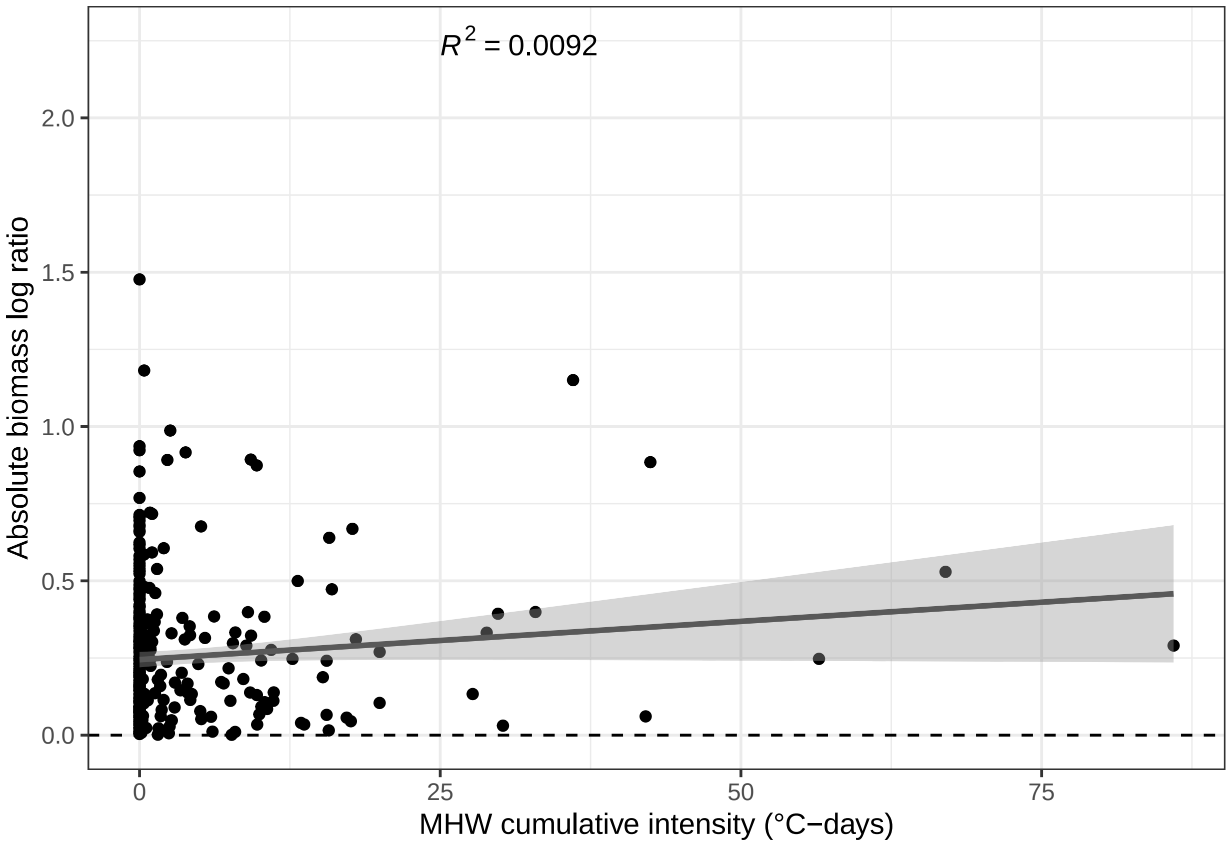


Supplementary Figure 7: Biomass change (log ratio) and three alternative metrics of MHW impacts: cumulative intensity calculated from the detrended GLORYS sea bottom temperature data with no five-day cutoff duration (°C-days), and duration (total number of MHW-days) and intensity (cumulative intensity divided by duration) calculated from the detrended GLORYS sea bottom temperature data with a minimum MHW duration of five days. The fitted lines are linear regressions. The shaded areas are 95% confidence intervals.

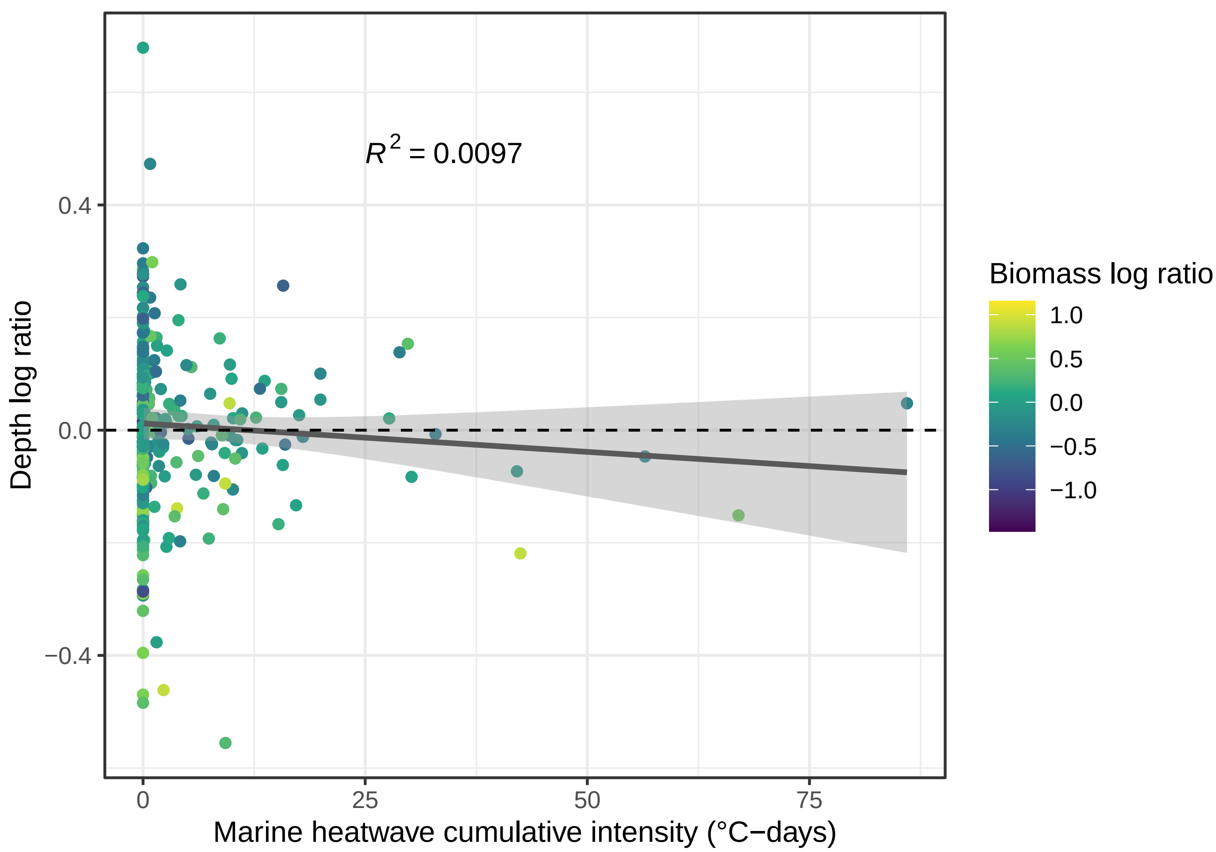


Supplementary Figure 8: Daily 95th percentile anomalies in the two MHW data sources: sea surface temperature from OISST and sea bottom temperature from GLORYS (both detrended). To simplify comparison we plot all anomalies, not just those MHWs that exceeded a five-day threshold. Note that the OISST time-series began in 1982 and GLORYS began in 1993. Region names are listed in Supp. Tab. 1.

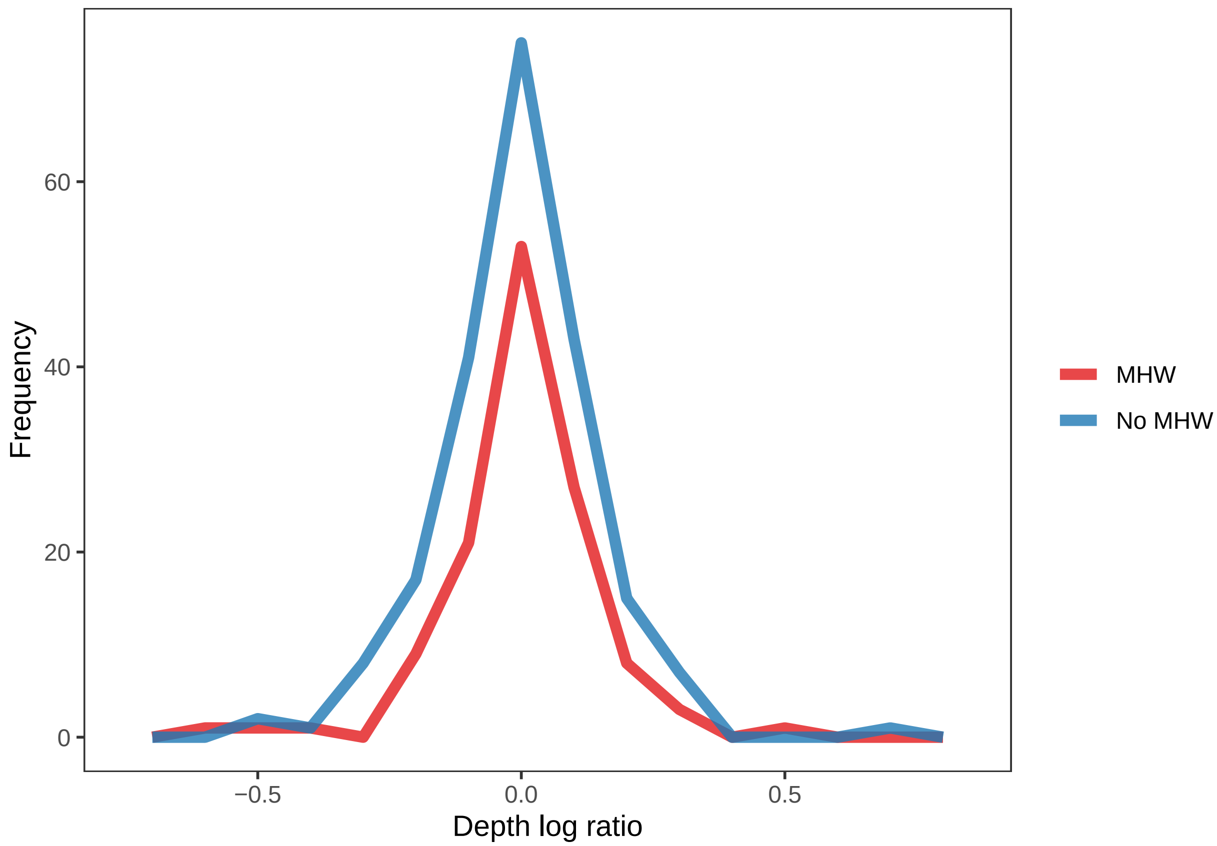
3 Supplementary figures: exploring additional predictors



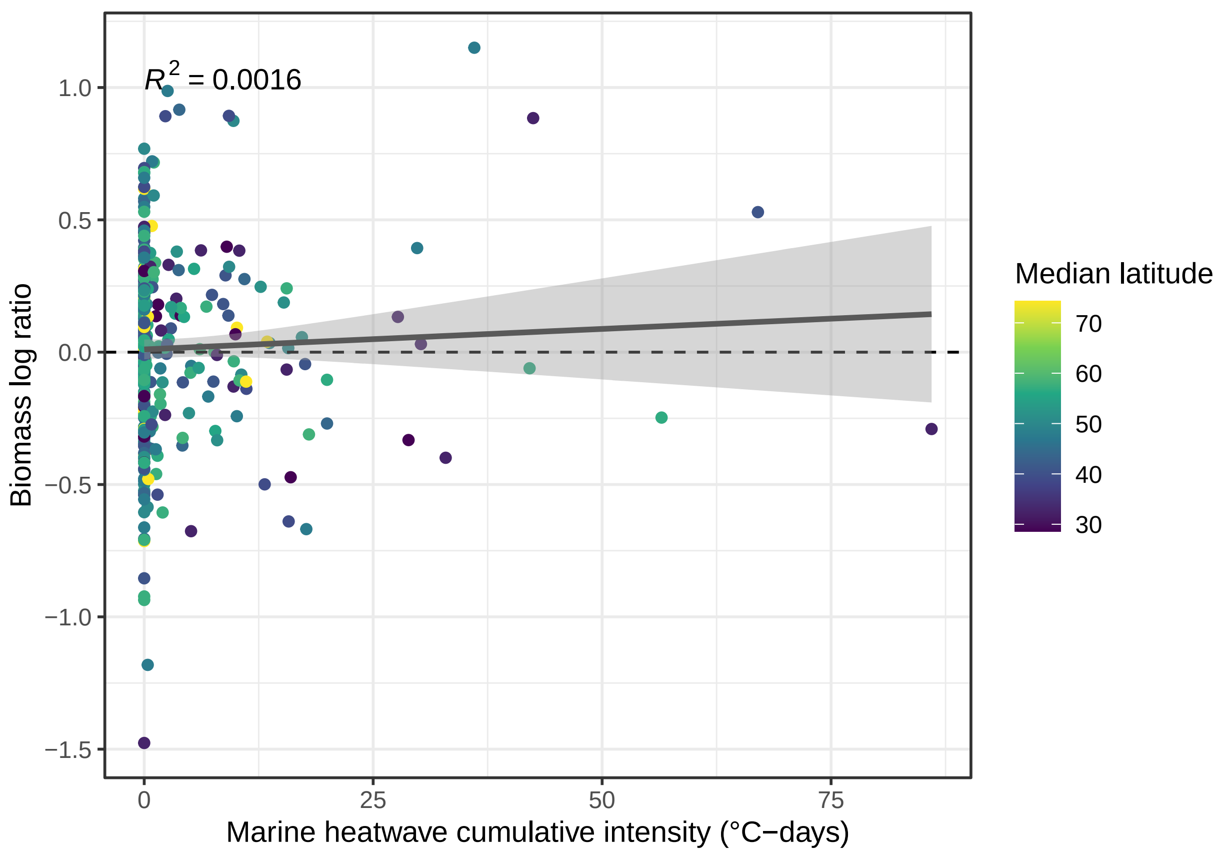
Supplementary Figure 9: MHW cumulative intensity (total anomaly in °C-days) and absolute value of biomass log ratio. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. The fitted line is a linear regression. The shaded area is its 95% confidence interval.



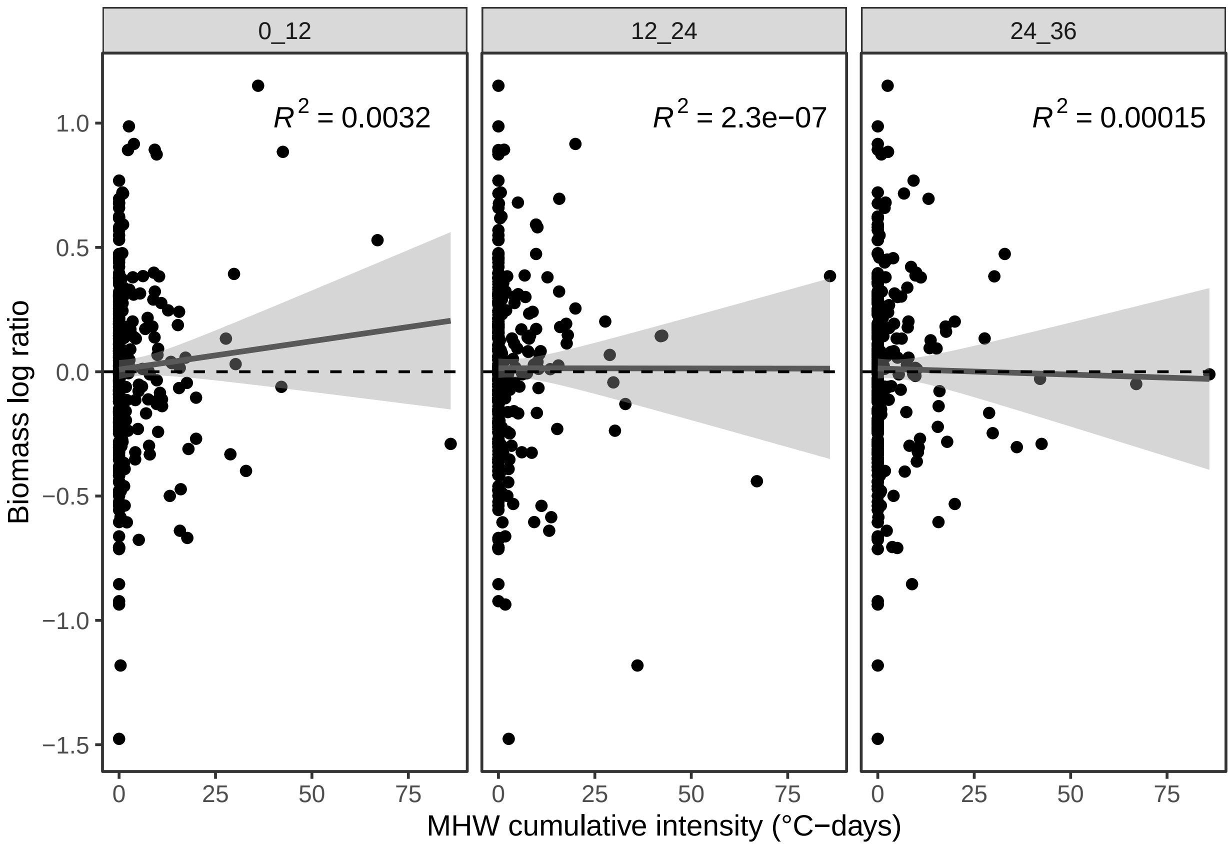
Supplementary Figure 10: Fish assemblage depth change (log ratio) and MHW cumulative intensity (total anomaly in °C-days). MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. The fitted line is a linear regression. The shaded area is its 95% confidence interval.



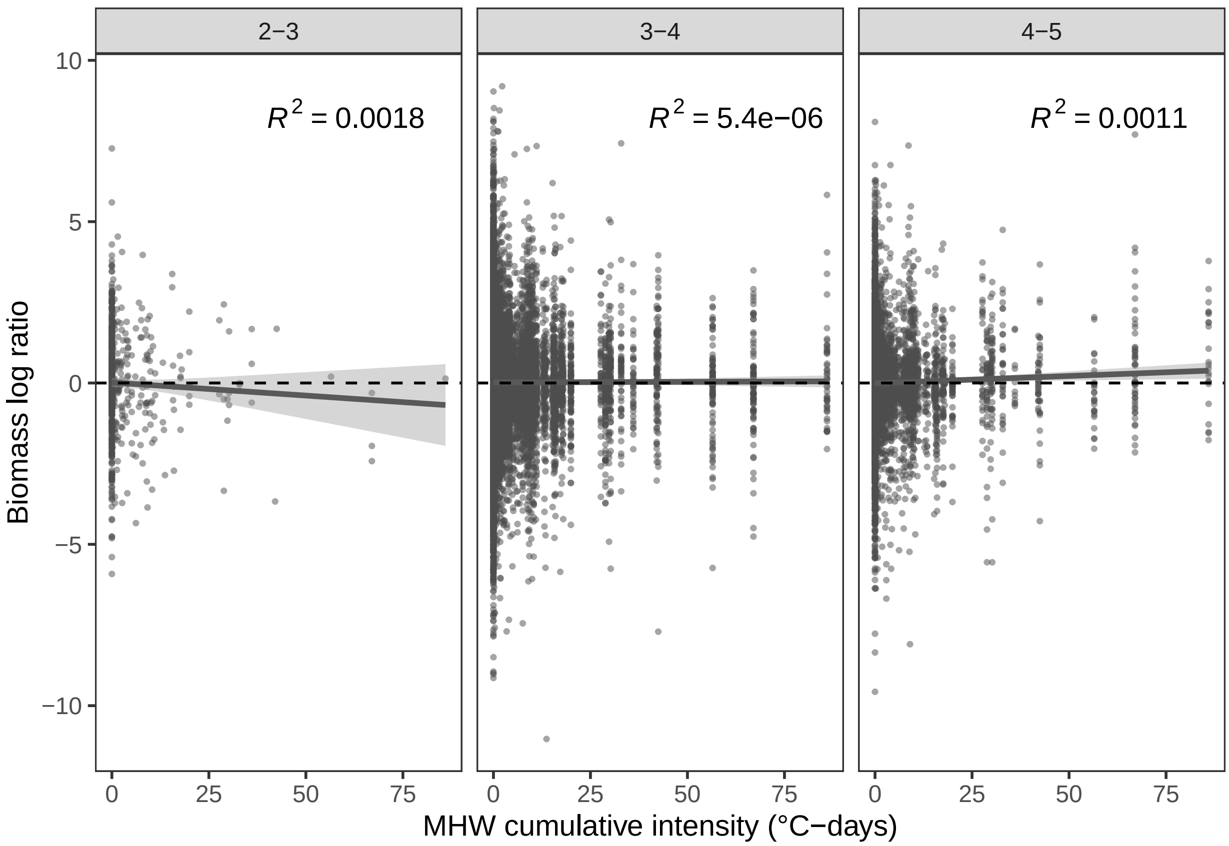
Supplementary Figure 11: Fish assemblage depth change (log ratio) and MHW occurrence. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text.



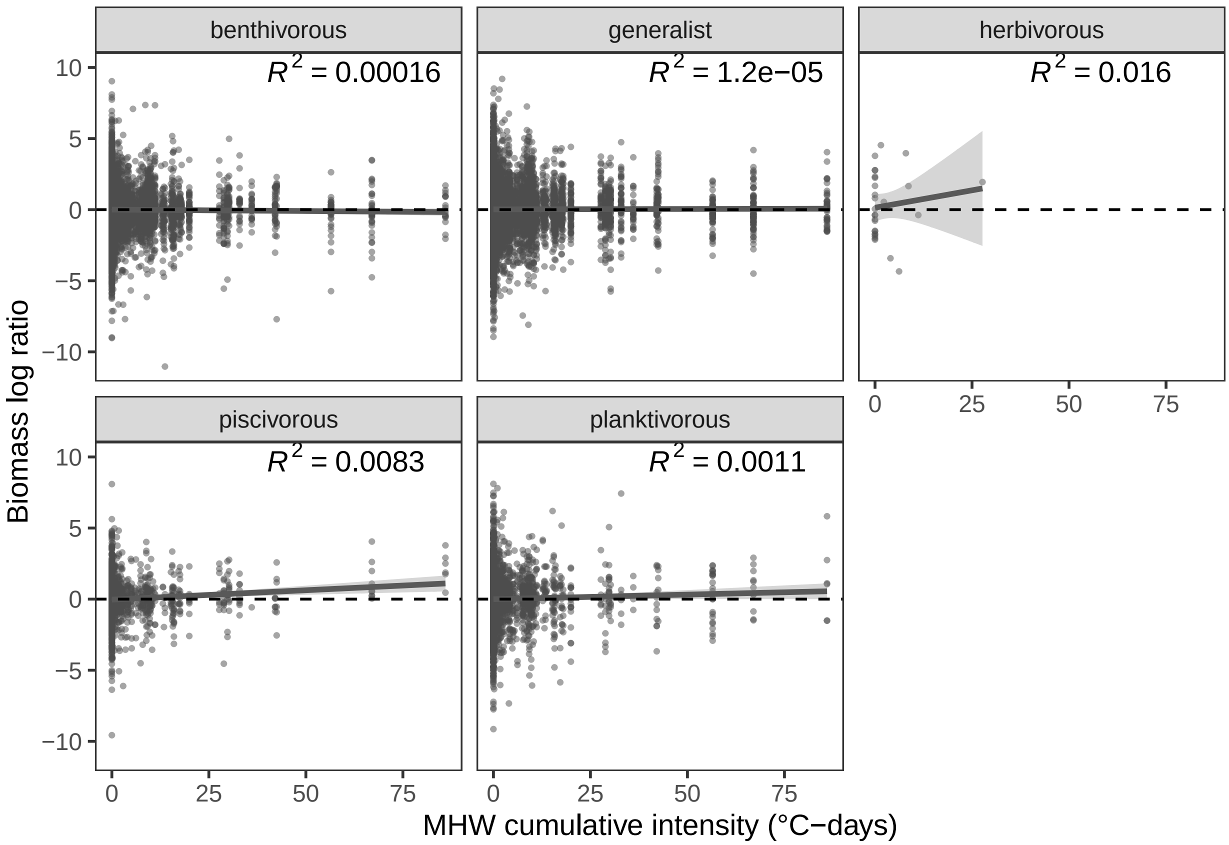
Supplementary Figure 12: Biomass change (log ratio) and MHW cumulative intensity (total anomaly in °C-days), color-coded by median latitude of each survey region. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. The fitted line is a linear regression. The shaded area is its 95% confidence interval.



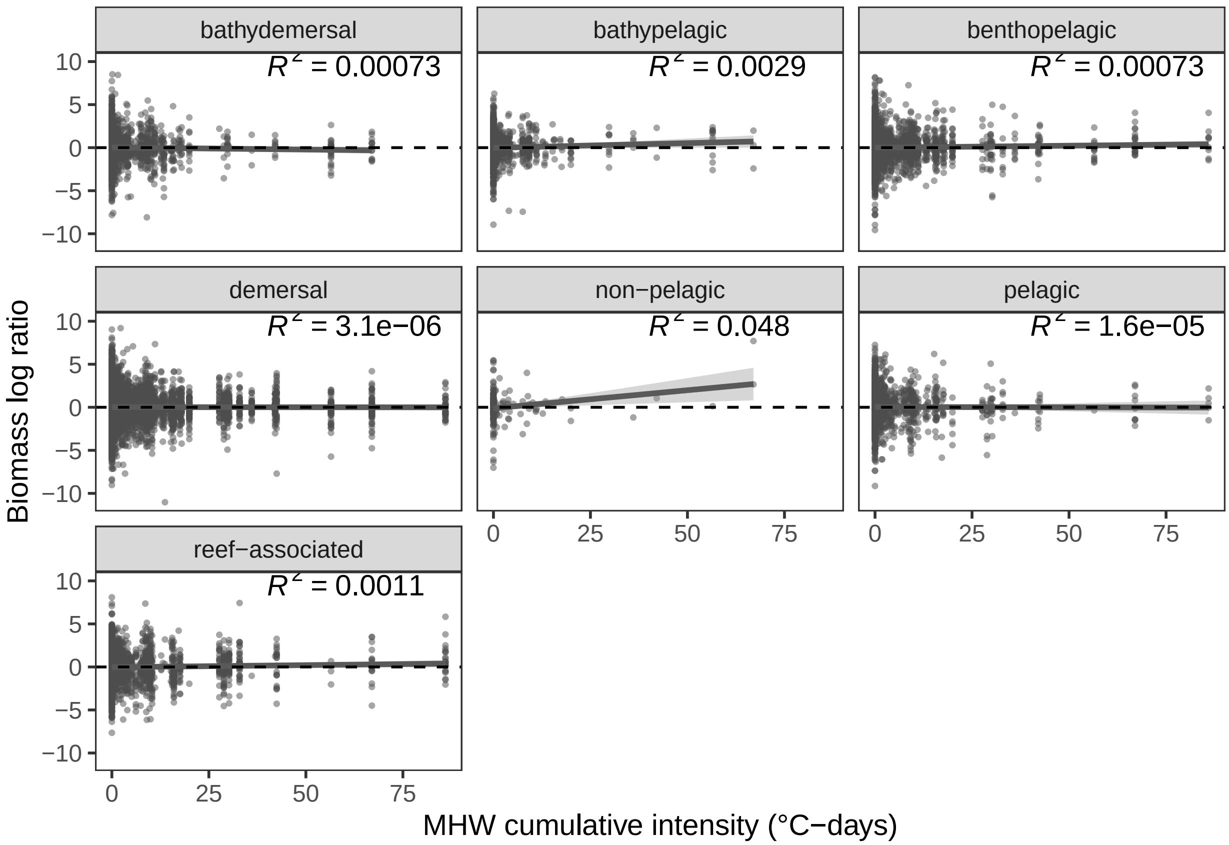
Supplementary Figure 13: Biomass change (log ratio) and MHW cumulative intensity (total anomaly in °C-days) calculated the preceding year as in the main text (0-12 months), a one-year lag (12-24 months), and a two-year lag (24-36 months). MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. Fitted lines are linear regressions. Shaded areas are 95% confidence intervals.



Supplementary Figure 14: Biomass log ratio and MHW cumulative intensity (total anomaly in °C-days) grouped by trophic level of each taxon. Trophic levels are binned (2-3, 3-4, and 4-5). MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. Fitted lines are linear regressions. Shaded areas are 95% confidence intervals.

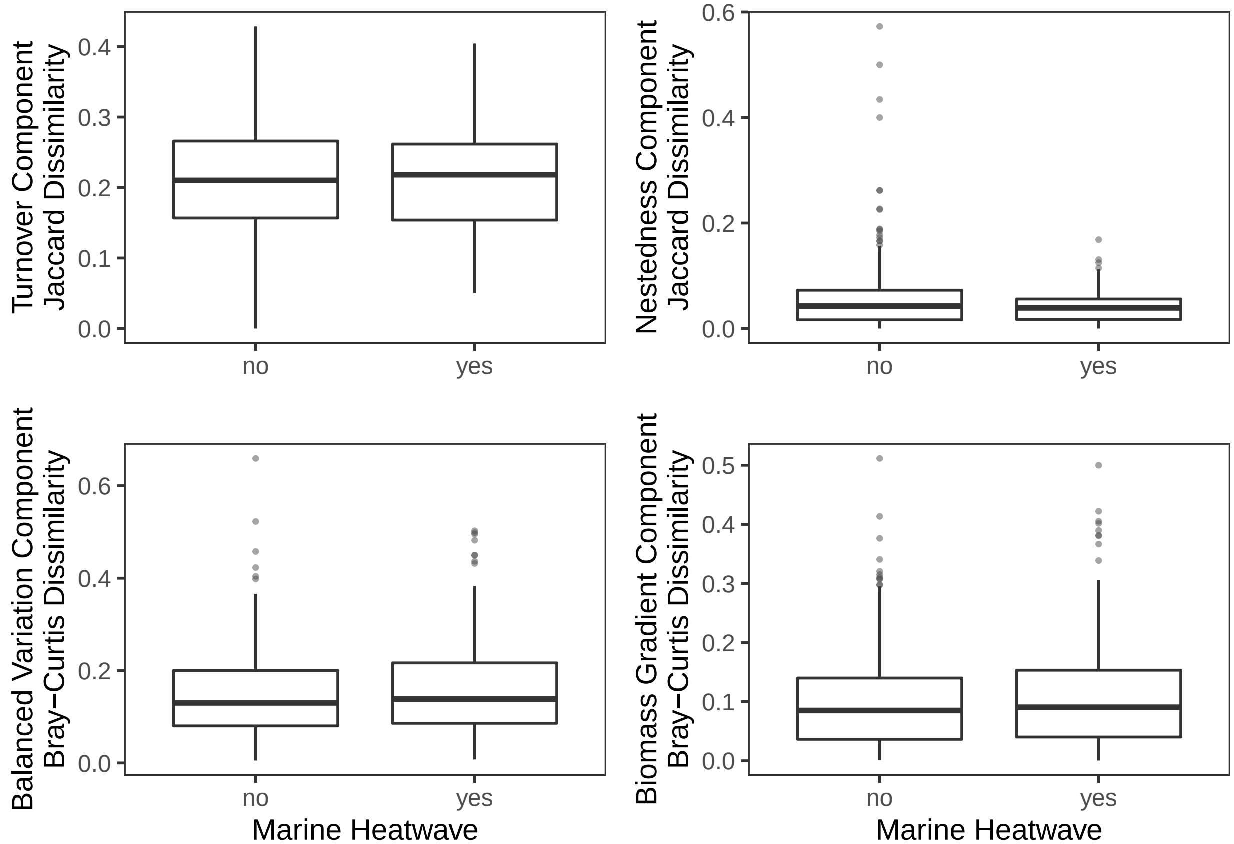


Supplementary Figure 15: Biomass log ratio and MHW cumulative intensity (total anomaly in °C-days) grouped by feeding mode of each taxon. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. Fitted lines are linear regressions. Shaded areas are 95% confidence intervals.



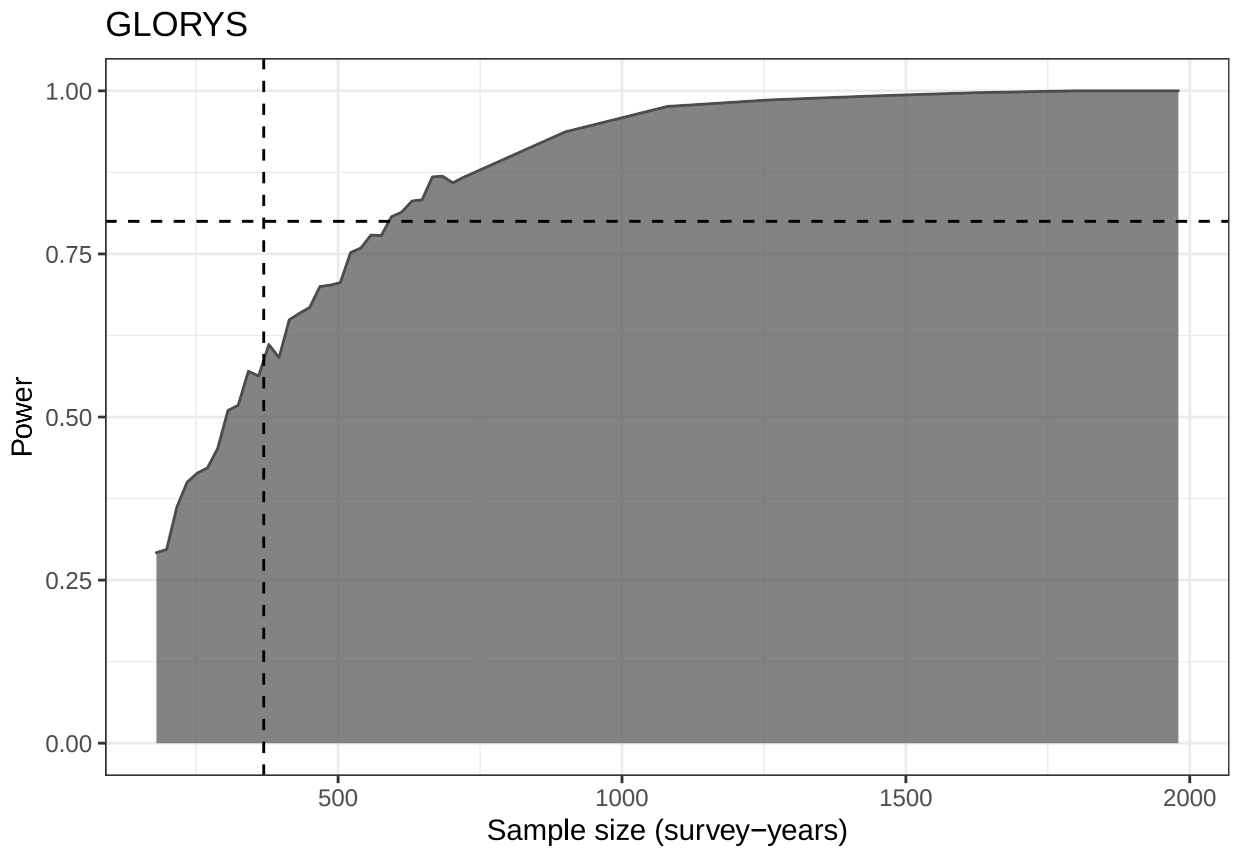
Supplementary Figure 16: Biomass log ratio and MHW cumulative intensity (total anomaly in °C-days) grouped by habitat preference of each taxon. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. Fitted lines are linear regressions. Shaded areas are 95% confidence intervals.

4 Supplementary figures: community dissimilarity

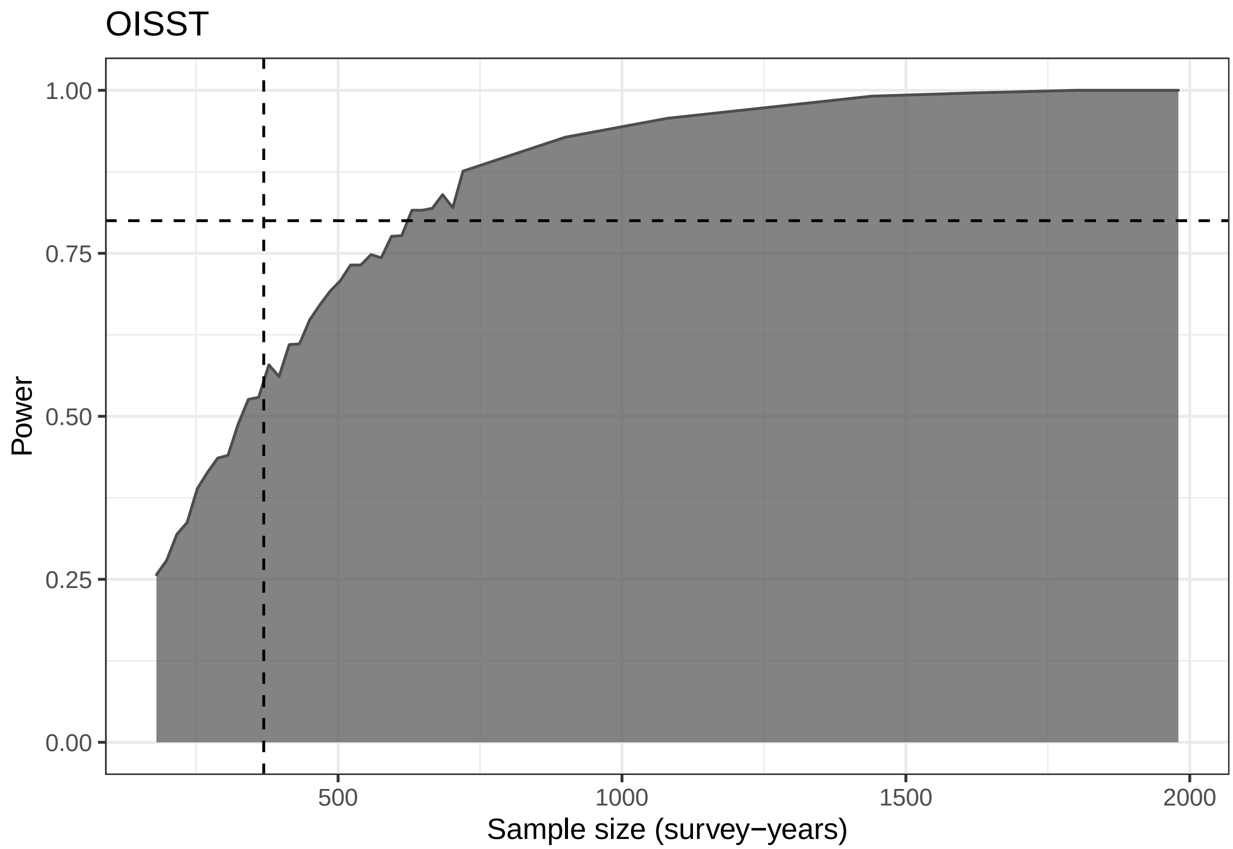


Supplementary Figure 17: Box-and-whisker plots of temporal community dissimilarity and MHW incidence for partitioned occurrence-based beta diversity metrics of substitution and subset (Jaccard turnover and nestedness, respectively; top) and partitioned biomass-based beta diversity metricsof substitution and subset of substitution and subset (Bray-Curtis balanced variation and biomass gradient, respectively; bottom). MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text.

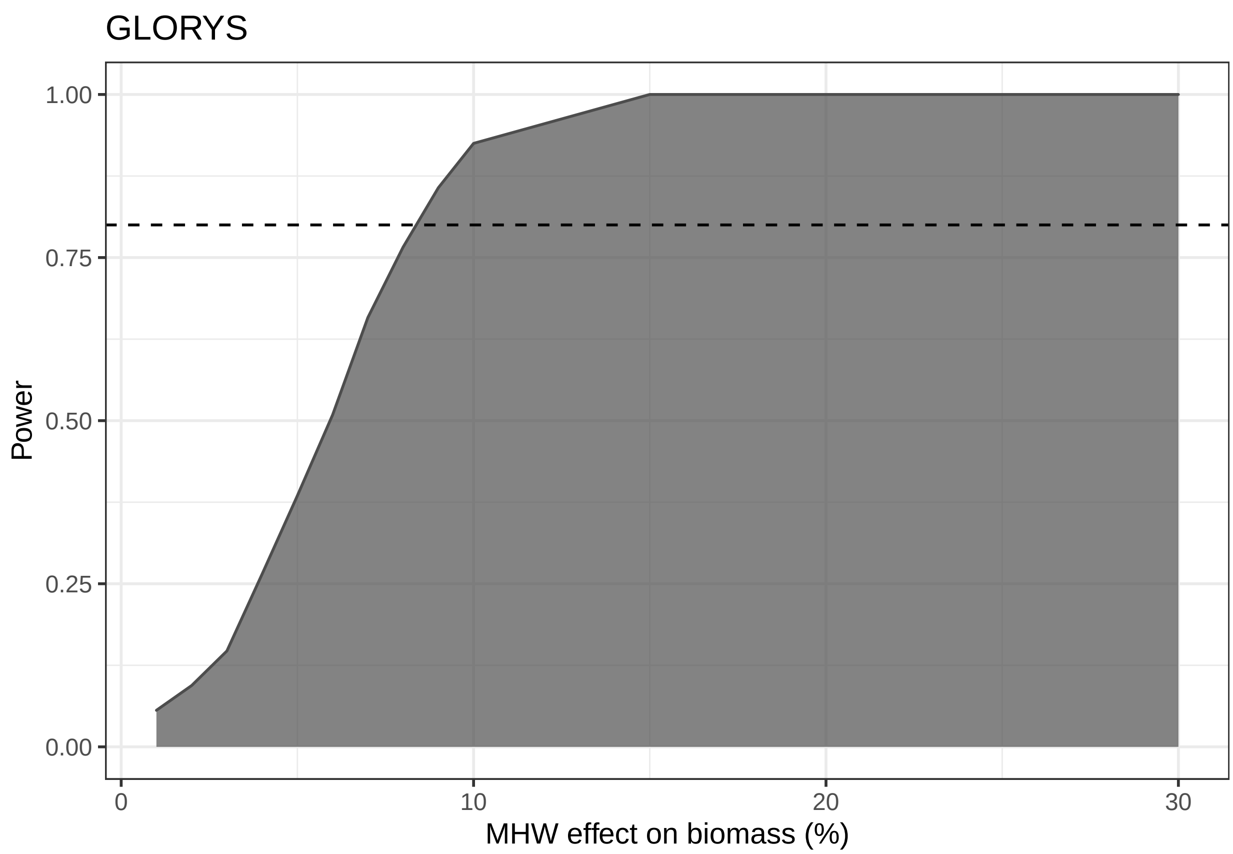
5 Supplementary figures: power analysis



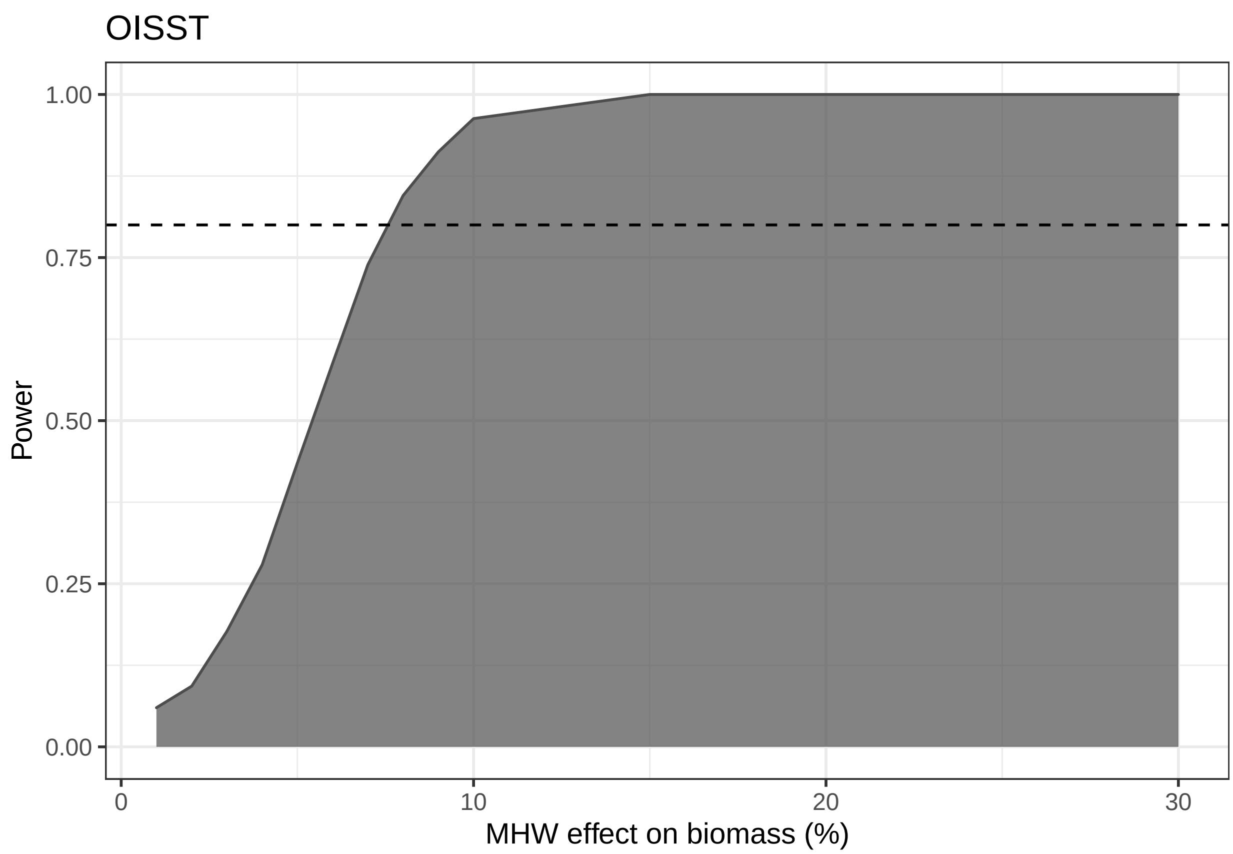
Supplementary Figure 18: Results from a power analysis applying our methods to a simulated dataset in which MHWs reduced biomass by 6% and study duration was varied. The sample sizes plotted are total survey-years across all regions. Dashed vertical line shows the sample size of our actual dataset. Dashed horizontal line denotes one conventionally accepted threshold for power (0.8). MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. Simulations were run to 200 years per survey (3600 total survey-years across the 18 regions) but truncated in this figure after power saturated at 1.0.



Supplementary Figure 19: Results from a power analysis applying our methods to a simulated dataset in which MHWs reduced biomass by 6% and study duration was varied. The sample sizes plotted are total survey-years across all regions. Dashed vertical line shows the sample size of our actual dataset. Dashed horizontal line denotes one conventionally accepted threshold for power (0.8). MHWs were calculated from the detrended OISST sea surface temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. Simulations were run to 200 years per survey (3600 total survey-years across the 18 regions) but truncated in this figure after power saturated at 1.0.

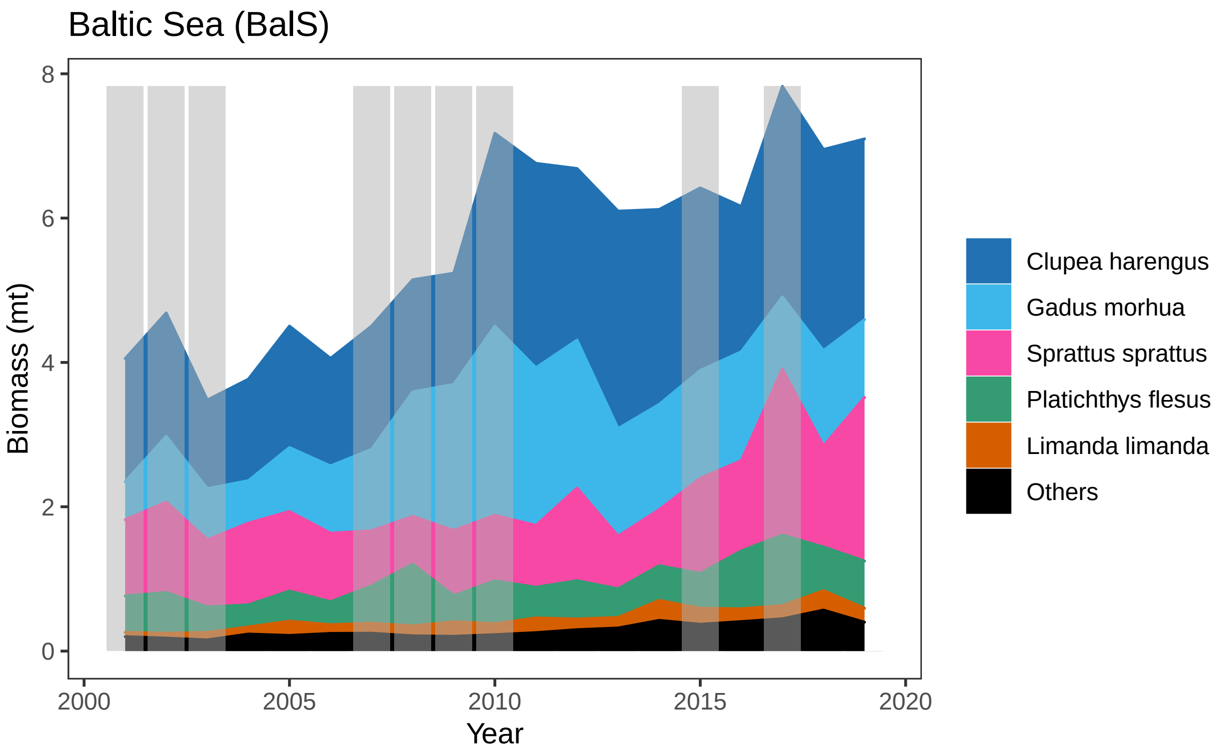


Supplementary Figure 20: Results from a power analysis applying our methods to a simulated dataset that varied the MHW effect on biomass over the true number of survey-years in our dataset ($n = 369$ total for GLORYS). Dashed horizontal line denotes one conventionally accepted threshold for power (0.8). MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text.

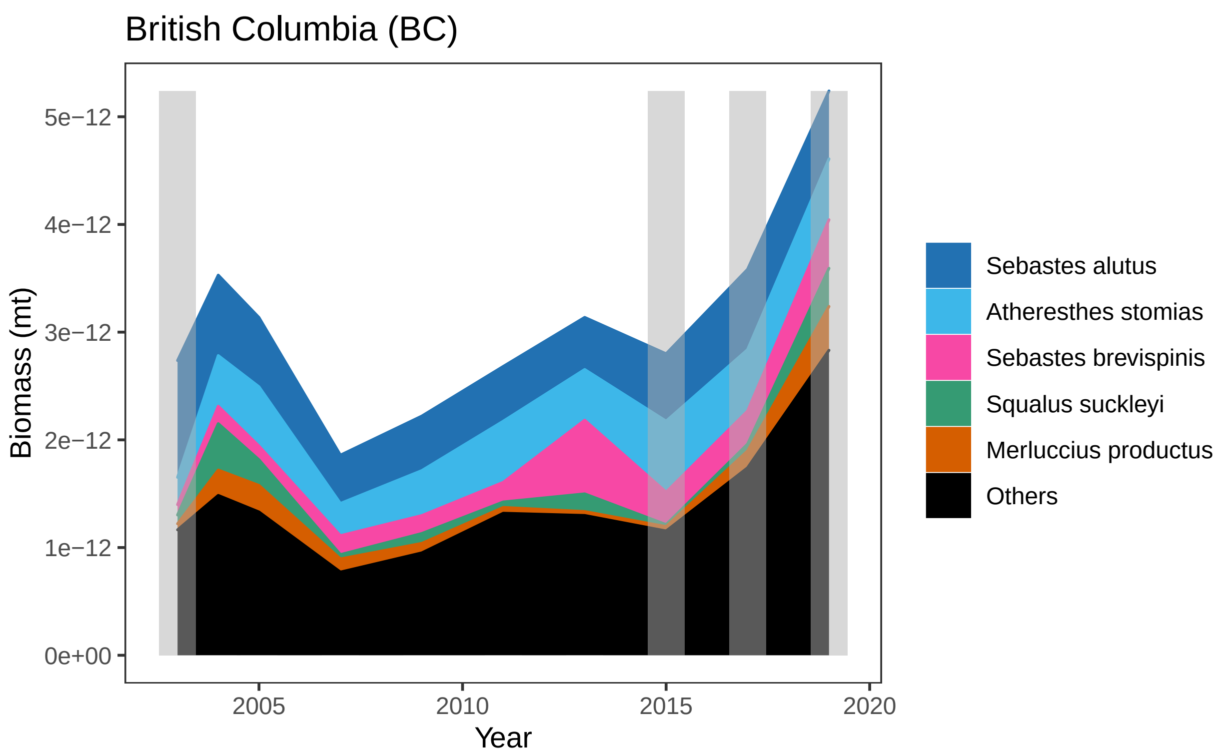


Supplementary Figure 21: Results from a power analysis applying our methods to a simulated dataset that varied the MHW effect on biomass over the true number of survey-years in our dataset ($n = 441$ total for OISST). The sample sizes plotted are total survey-years across all regions. Dashed horizontal line denotes one conventionally accepted threshold for power (0.8). MHWs were calculated from the detrended OISST sea surface temperature data with a five-day minimum duration threshold for MHWs, as used in the main text.

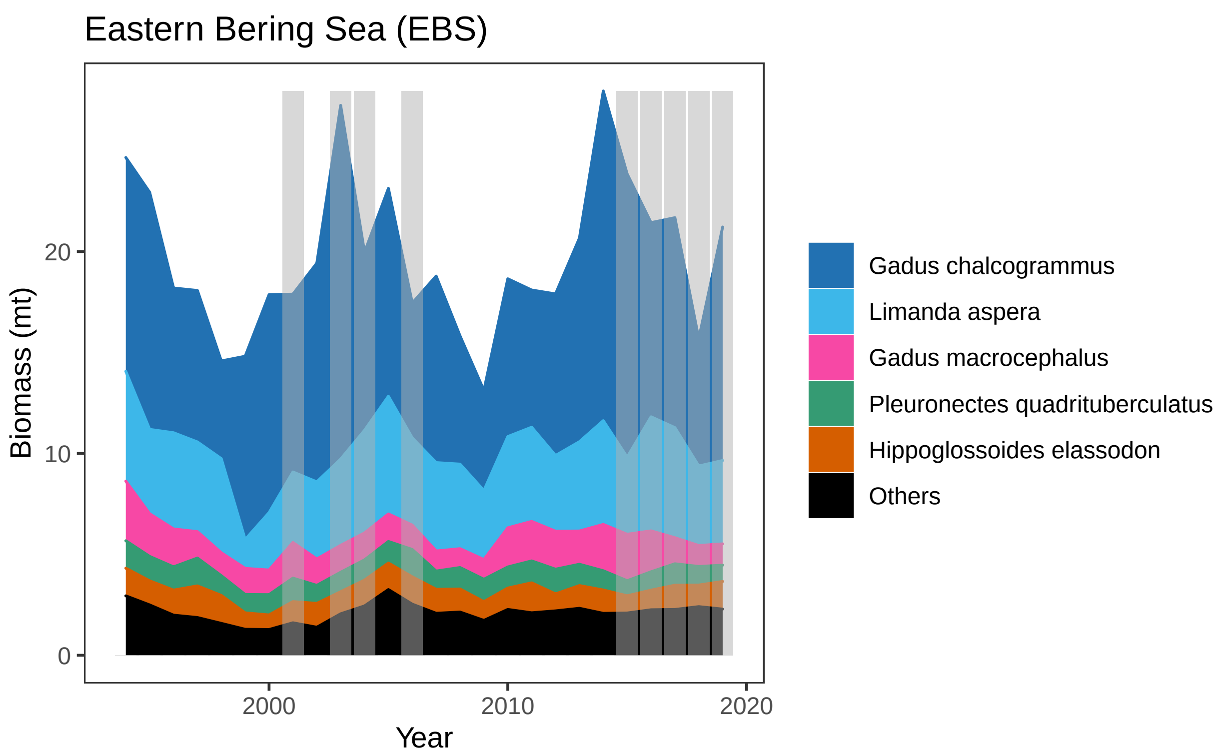
6 Supplementary figures: regional time-series



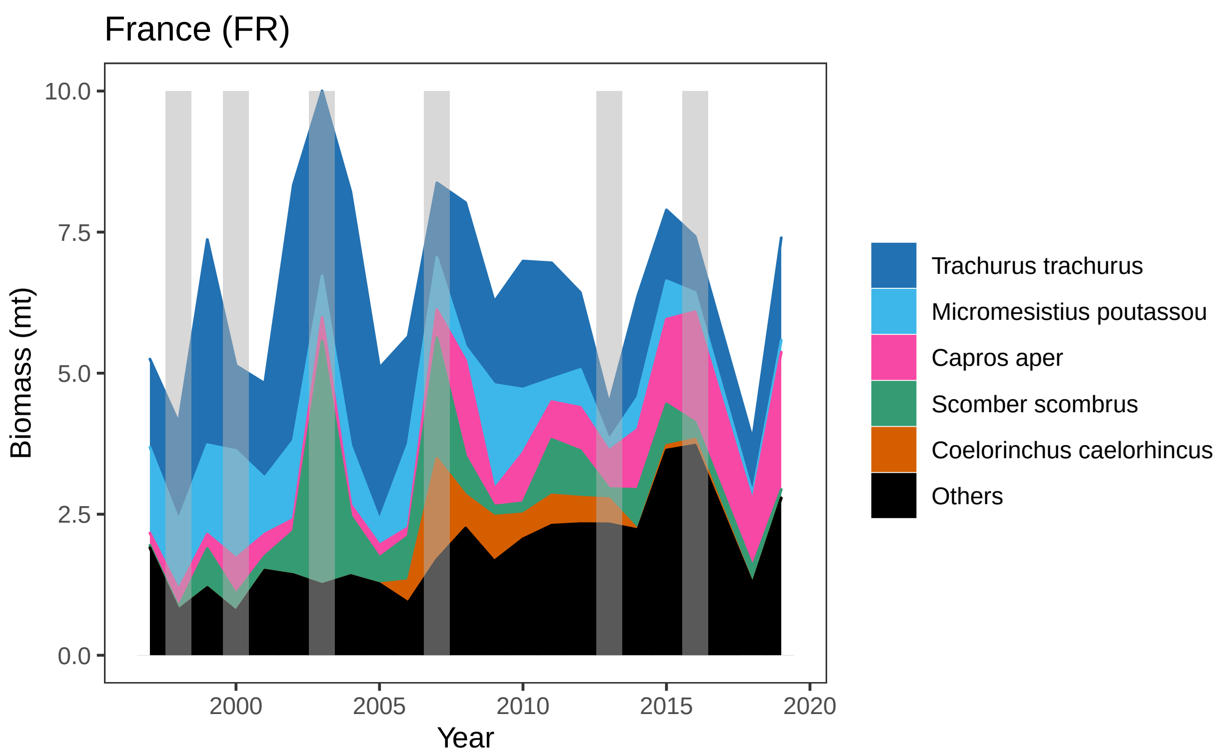
Supplementary Figure 22: Biomass trends and historical MHWs in a single region. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. The top five taxa by biomass are highlighted. Shaded grey rectangles denote when any MHWs occurred in the preceding survey-year.



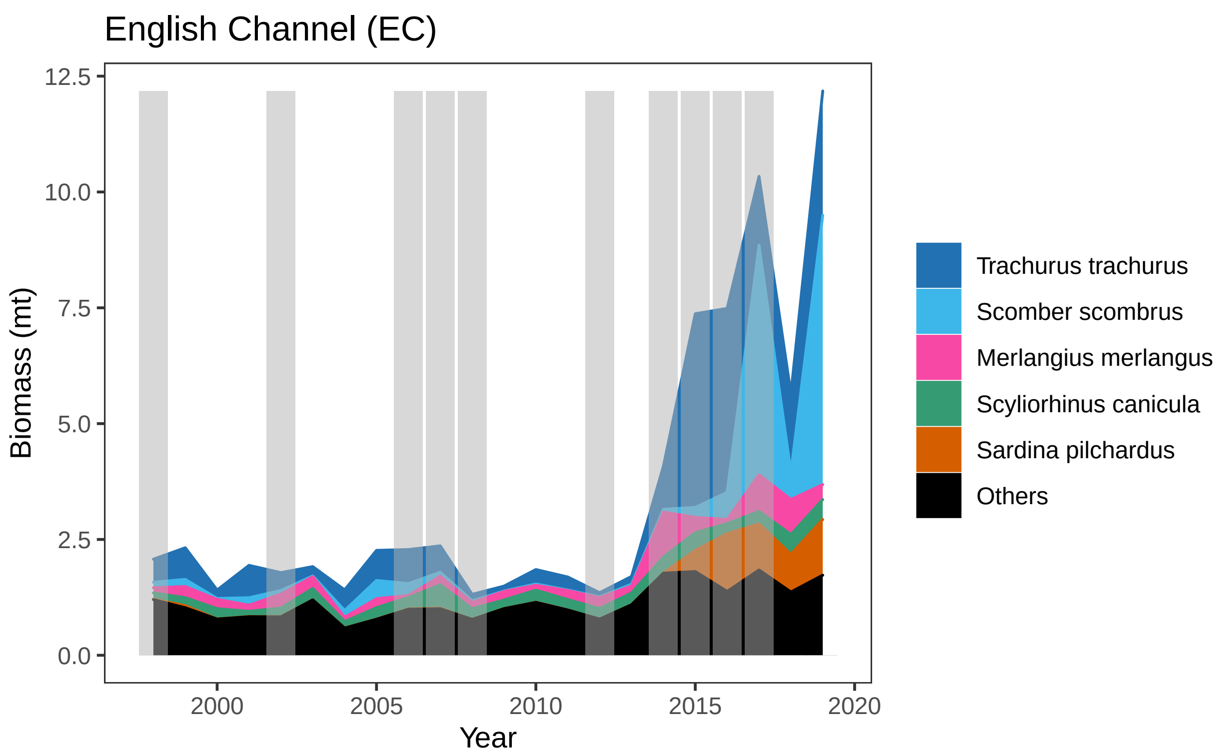
Supplementary Figure 23: Biomass trends and historical MHWs in a single region. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. The top five taxa by biomass are highlighted. Shaded grey rectangles denote when any MHWs occurred in the preceding survey-year.



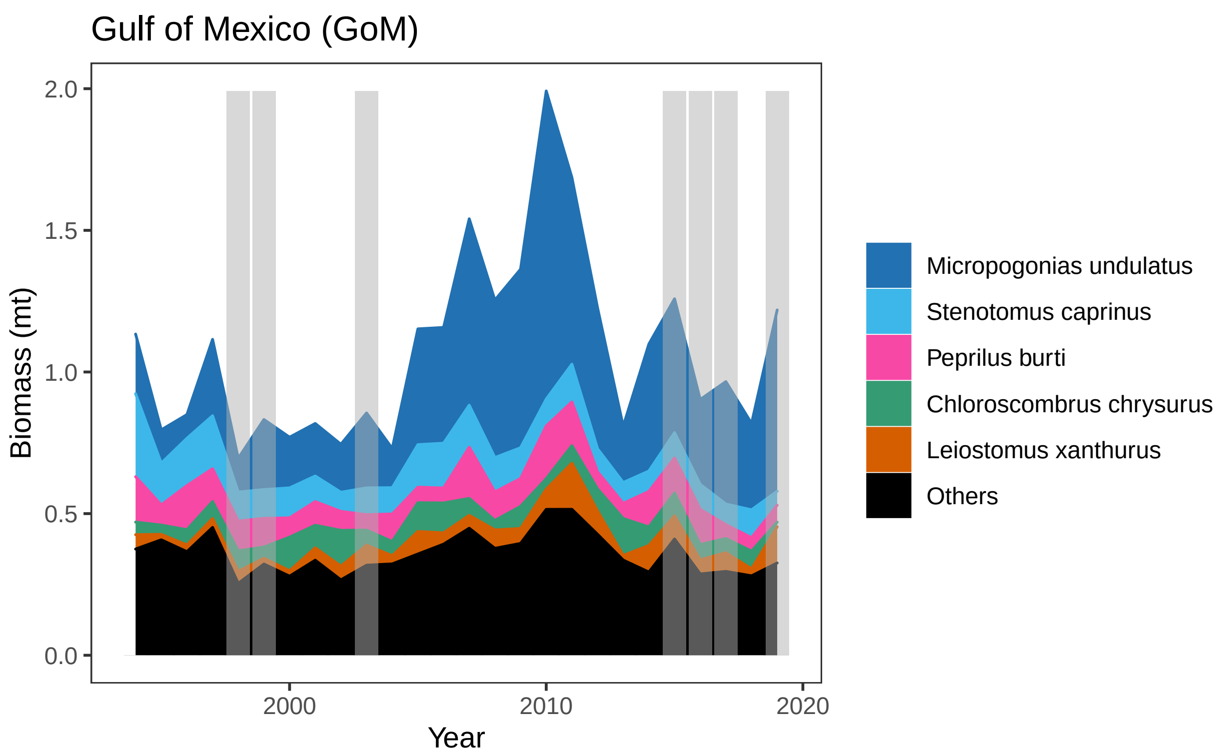
Supplementary Figure 24: Biomass trends and historical MHWs in a single region. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. The top five taxa by biomass are highlighted. Shaded grey rectangles denote when any MHWs occurred in the preceding survey-year.



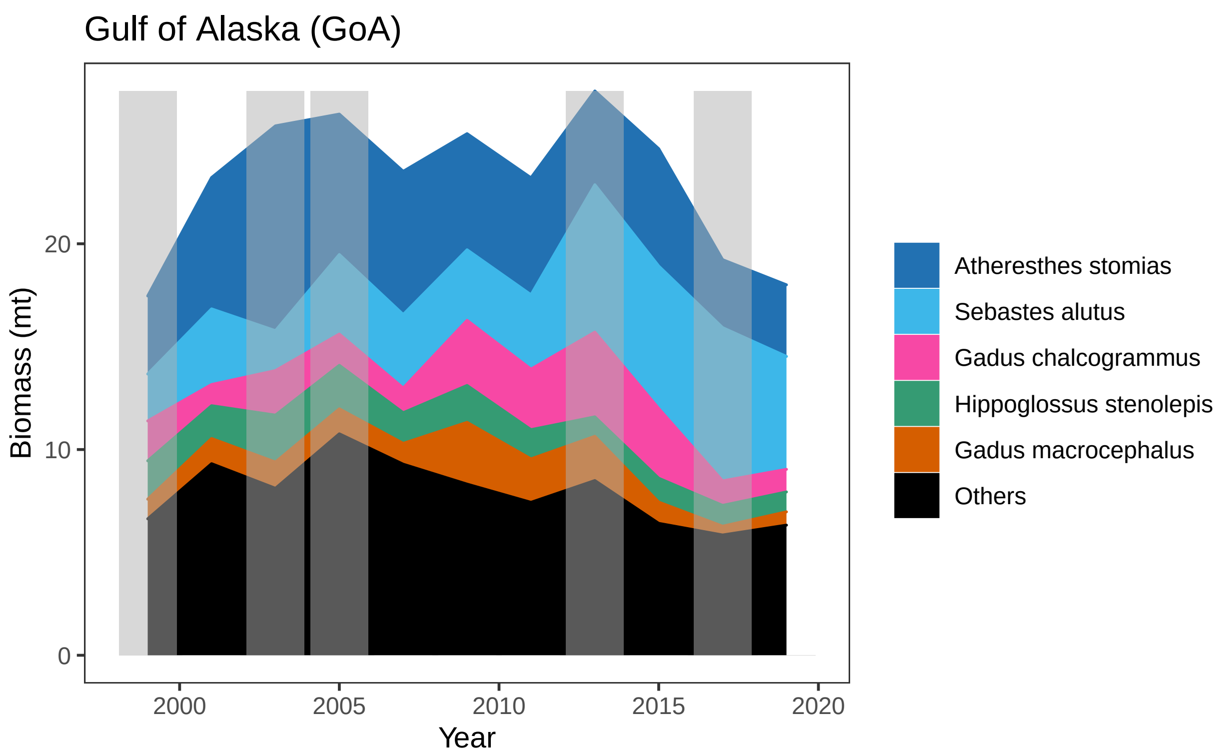
Supplementary Figure 25: Biomass trends and historical MHWs in a single region. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. The top five taxa by biomass are highlighted. Shaded grey rectangles denote when any MHWs occurred in the preceding survey-year.



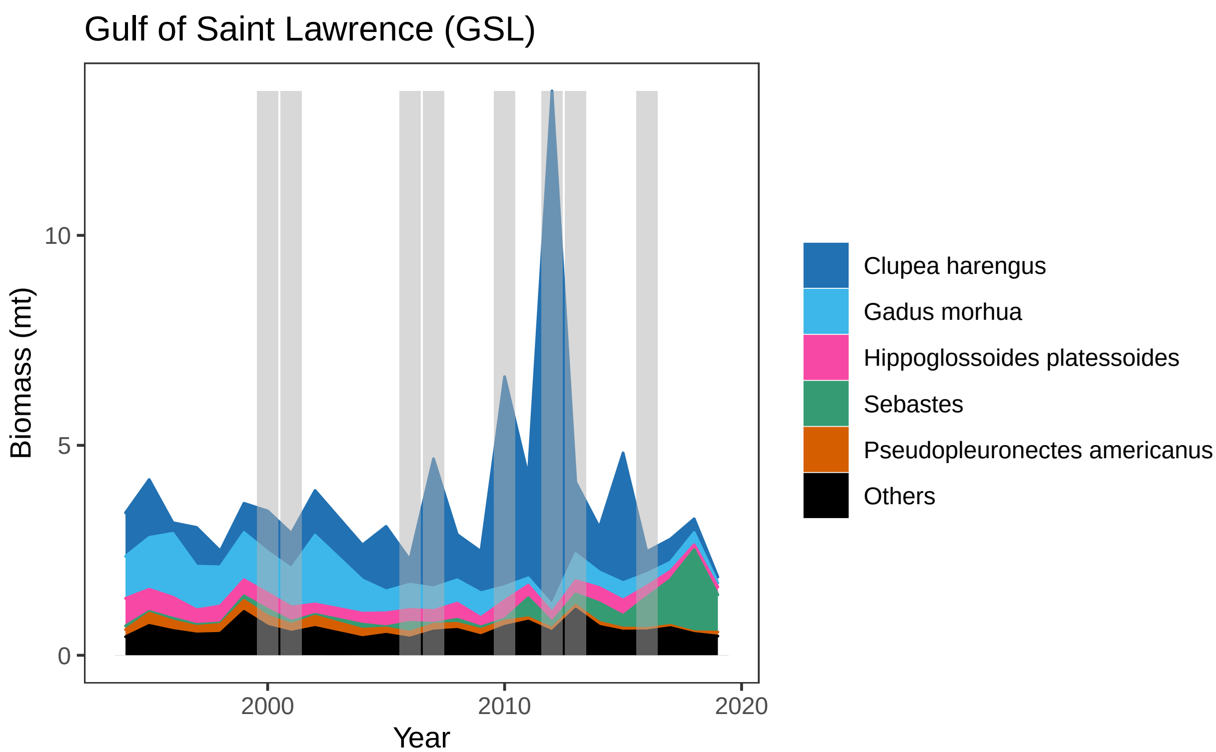
Supplementary Figure 26: Biomass trends and historical MHWs in a single region. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. The top five taxa by biomass are highlighted. Shaded grey rectangles denote when any MHWs occurred in the preceding survey-year.



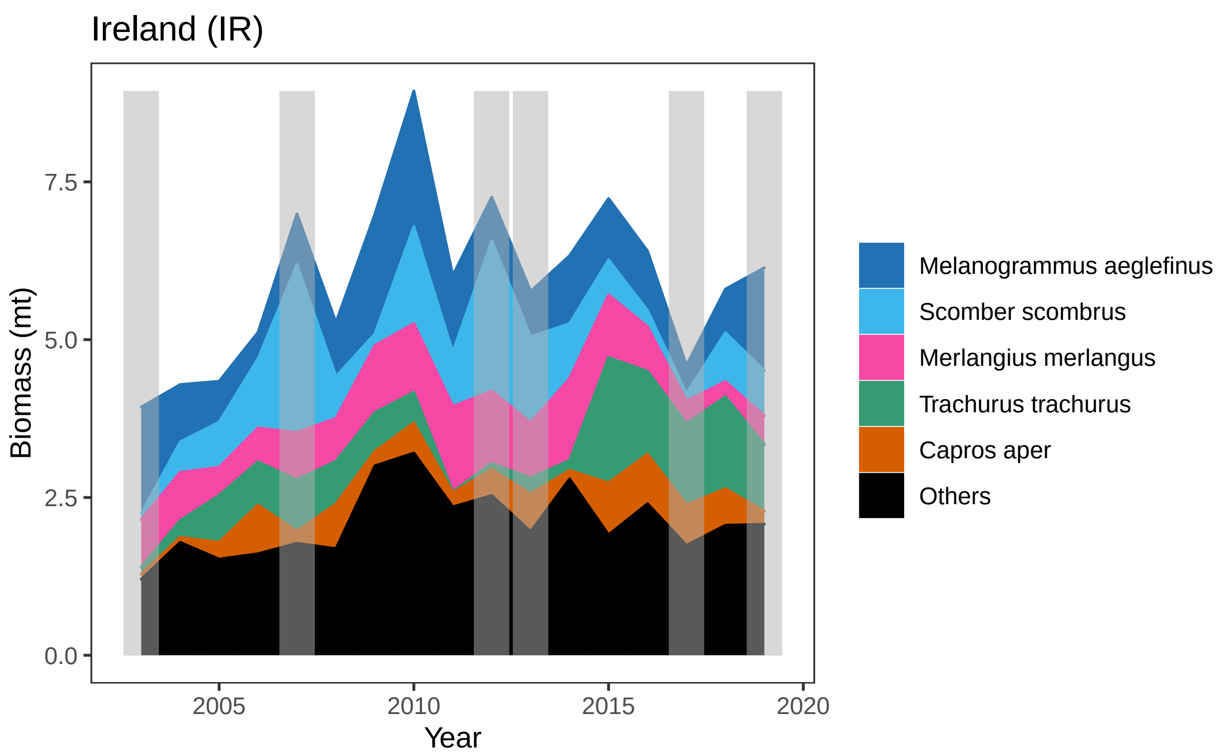
Supplementary Figure 27: Biomass trends and historical MHWs in a single region. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. The top five taxa by biomass are highlighted. Shaded grey rectangles denote when any MHWs occurred in the preceding survey-year.



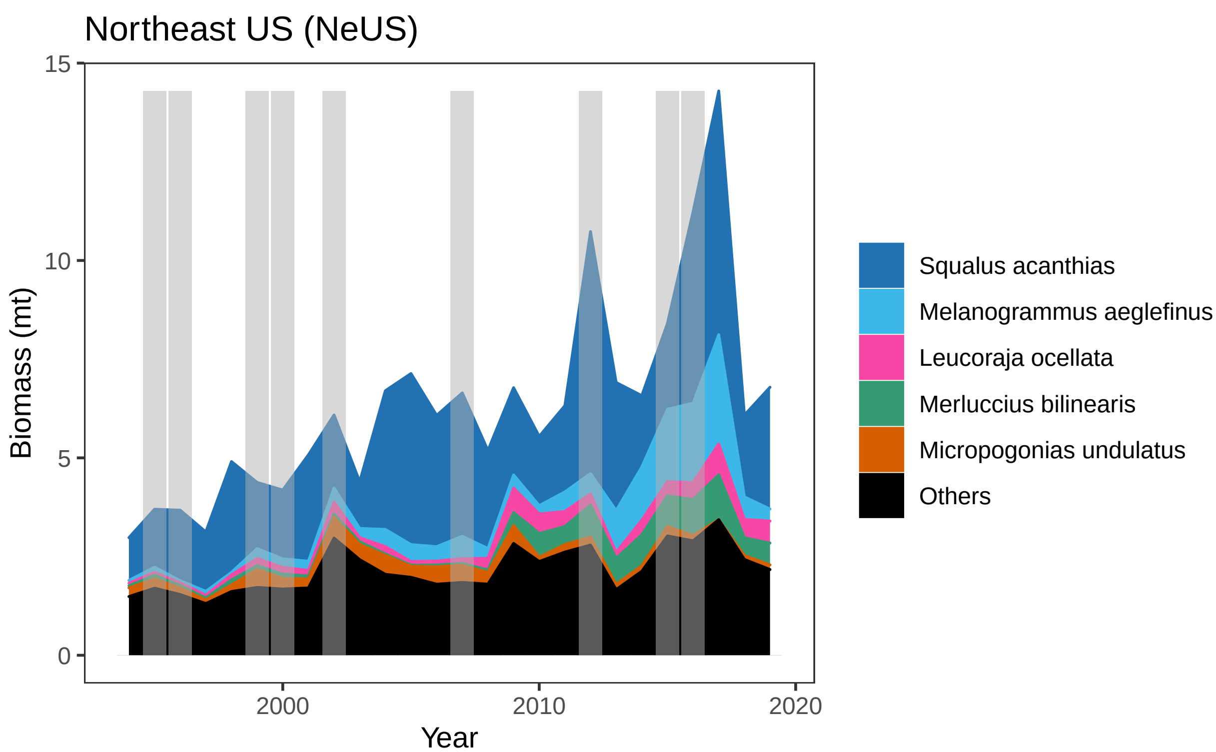
Supplementary Figure 28: Biomass trends and historical MHWs in a single region. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. The top five taxa by biomass are highlighted. Shaded grey rectangles denote when any MHWs occurred in the preceding survey-year.



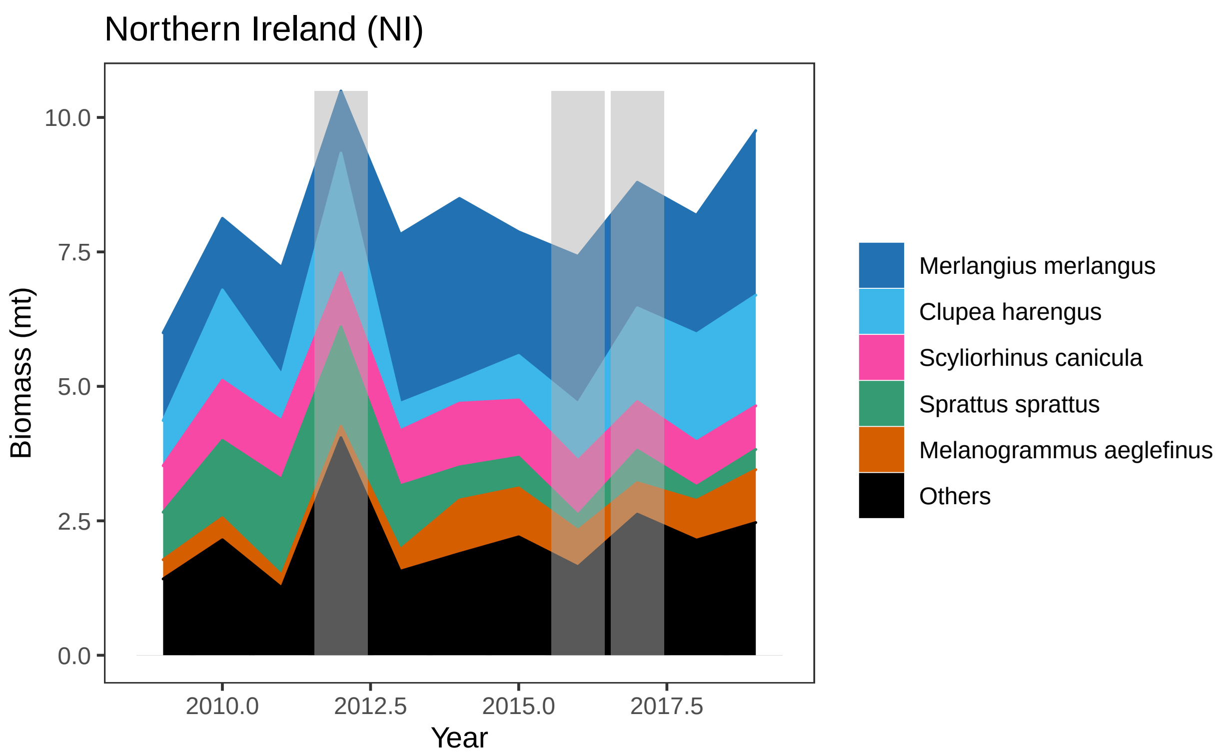
Supplementary Figure 29: Biomass trends and historical MHWs in a single region. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. The top five taxa by biomass are highlighted. Shaded grey rectangles denote when any MHWs occurred in the preceding survey-year.



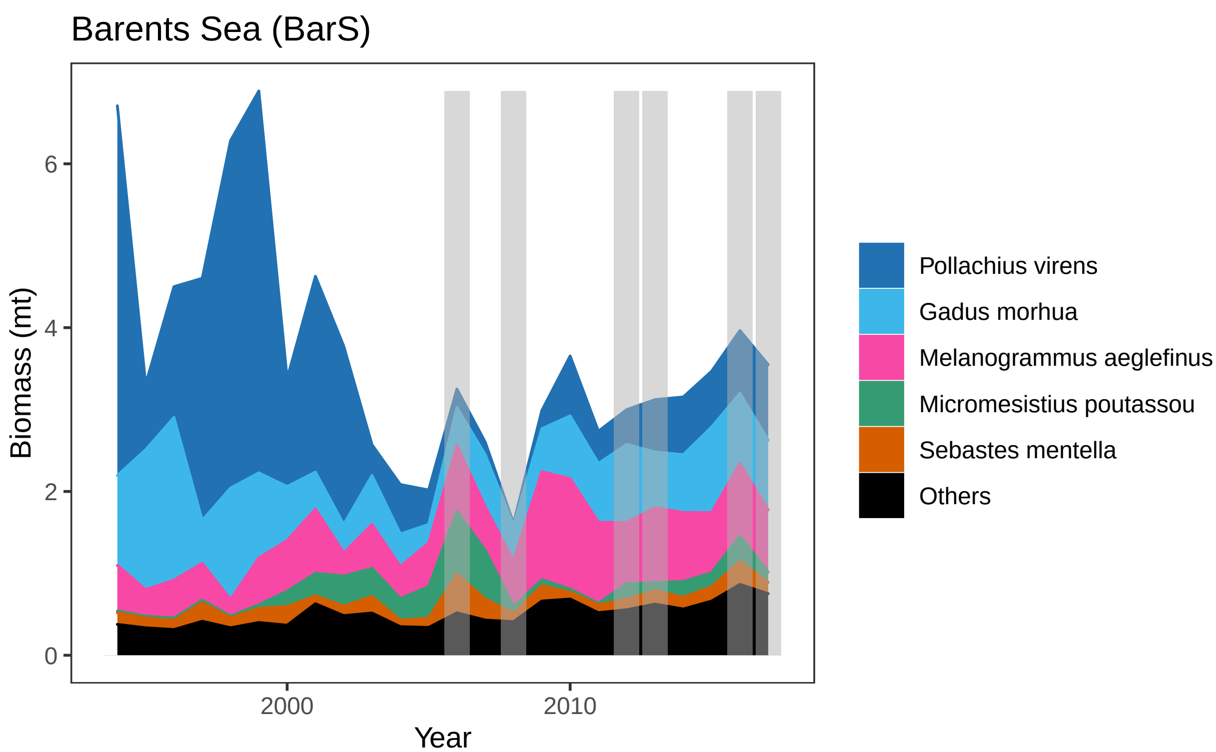
Supplementary Figure 30: Biomass trends and historical MHWs in a single region. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. The top five taxa by biomass are highlighted. Shaded grey rectangles denote when any MHWs occurred in the preceding survey-year.



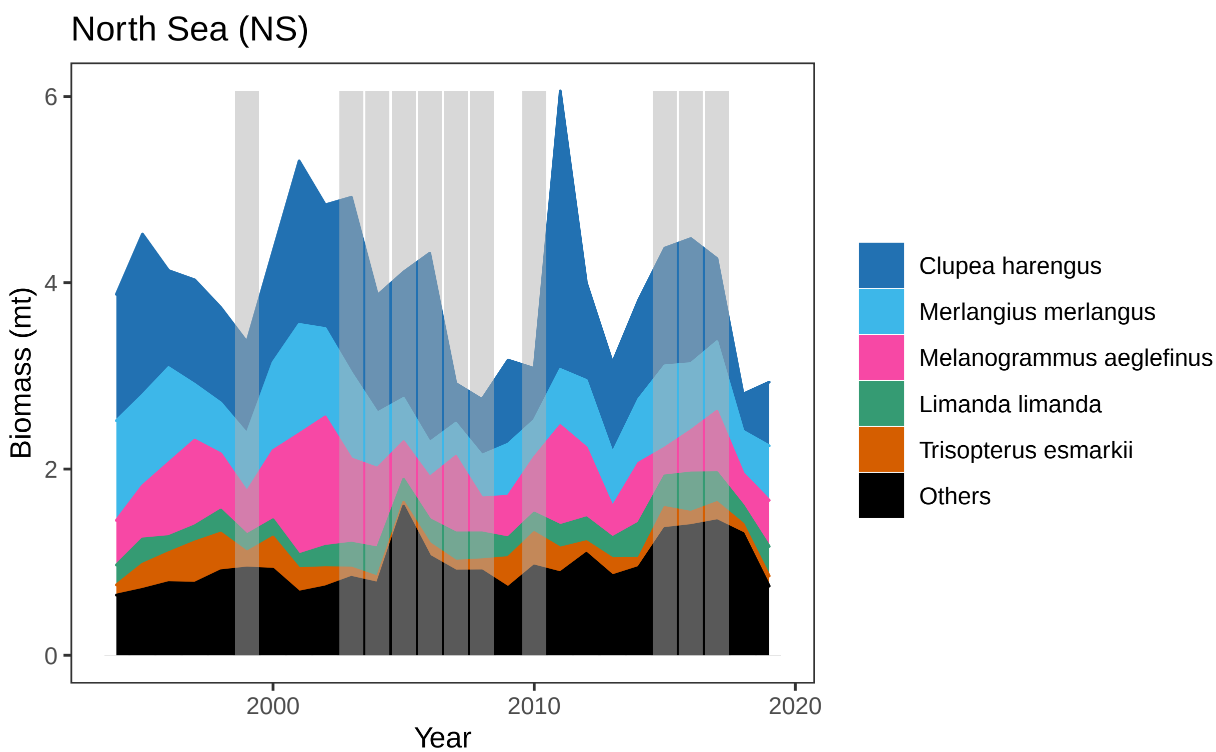
Supplementary Figure 31: Biomass trends and historical MHWs in a single region. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. The top five taxa by biomass are highlighted. Shaded grey rectangles denote when any MHWs occurred in the preceding survey-year.



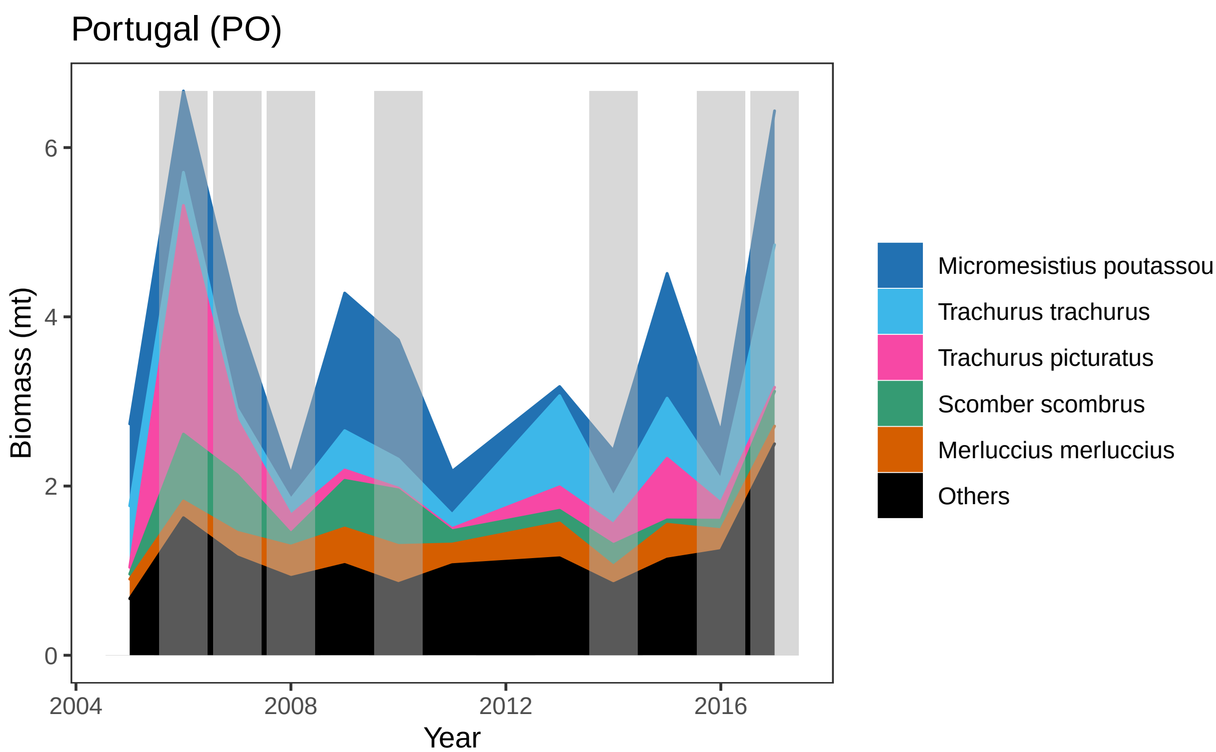
Supplementary Figure 32: Biomass trends and historical MHWs in a single region. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. The top five taxa by biomass are highlighted. Shaded grey rectangles denote when any MHWs occurred in the preceding survey-year.



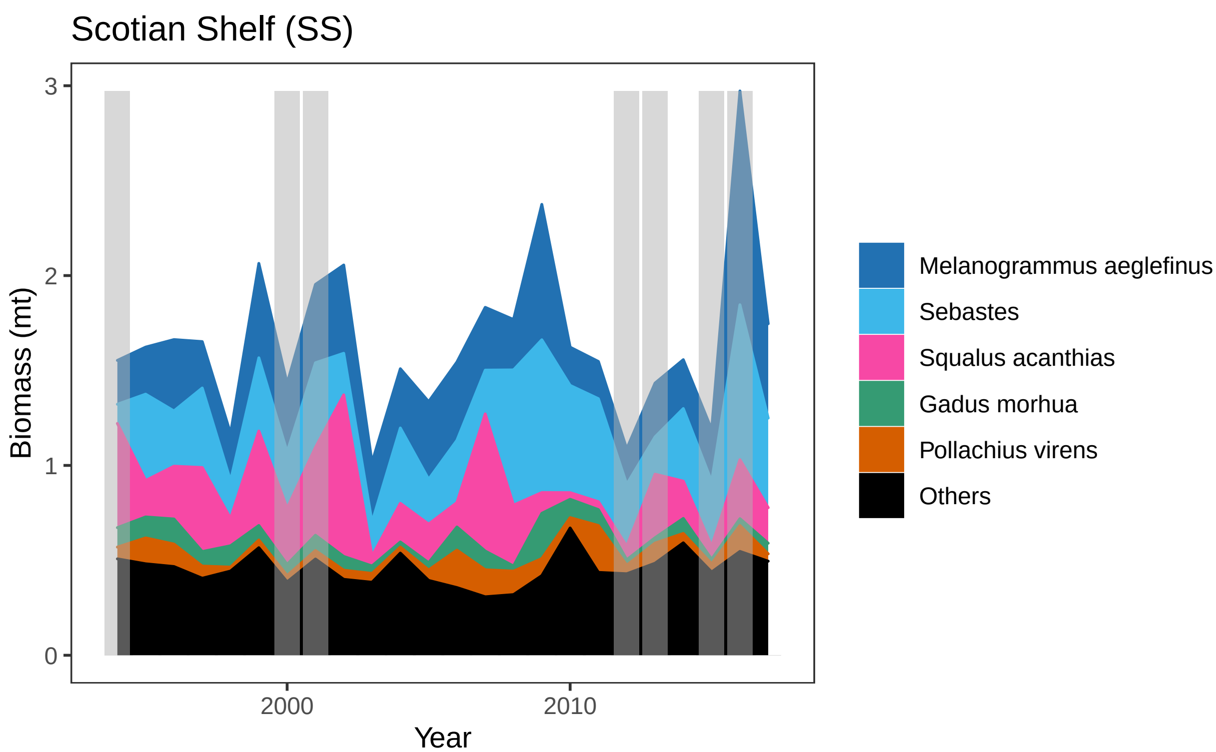
Supplementary Figure 33: Biomass trends and historical MHWs in a single region. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. The top five taxa by biomass are highlighted. Shaded grey rectangles denote when any MHWs occurred in the preceding survey-year.



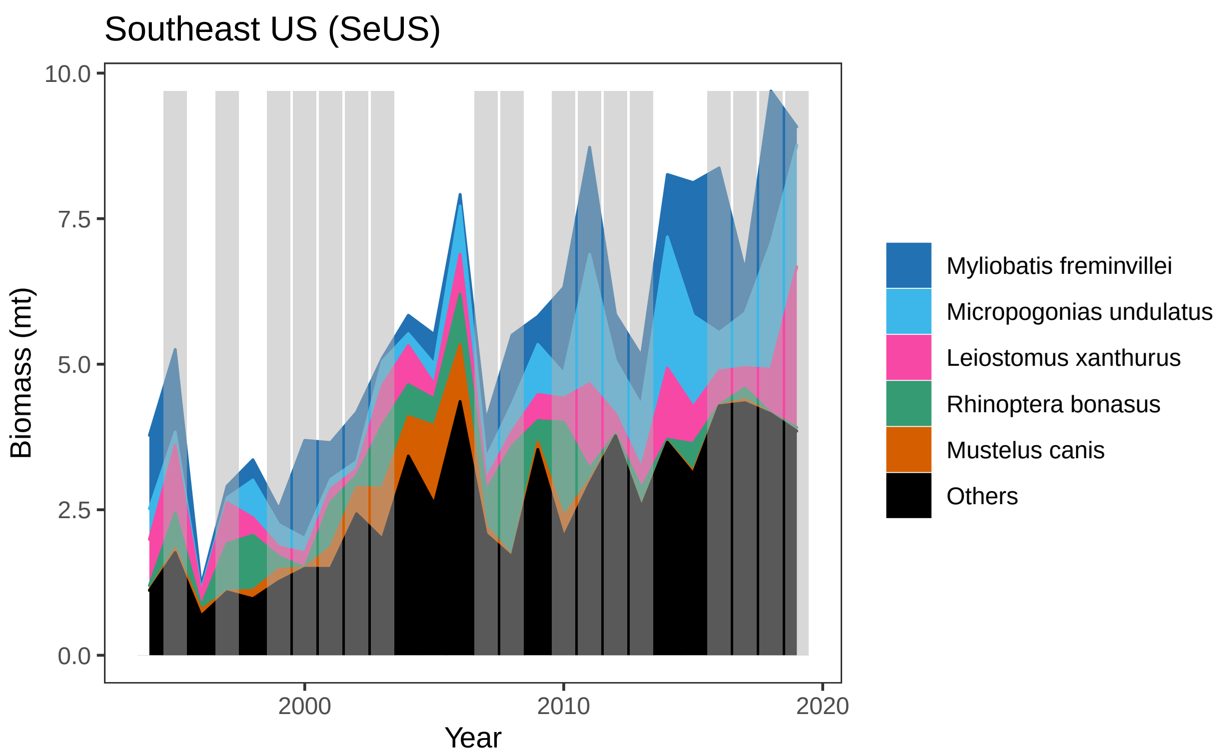
Supplementary Figure 34: Biomass trends and historical MHWs in a single region. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. The top five taxa by biomass are highlighted. Shaded grey rectangles denote when any MHWs occurred in the preceding survey-year.



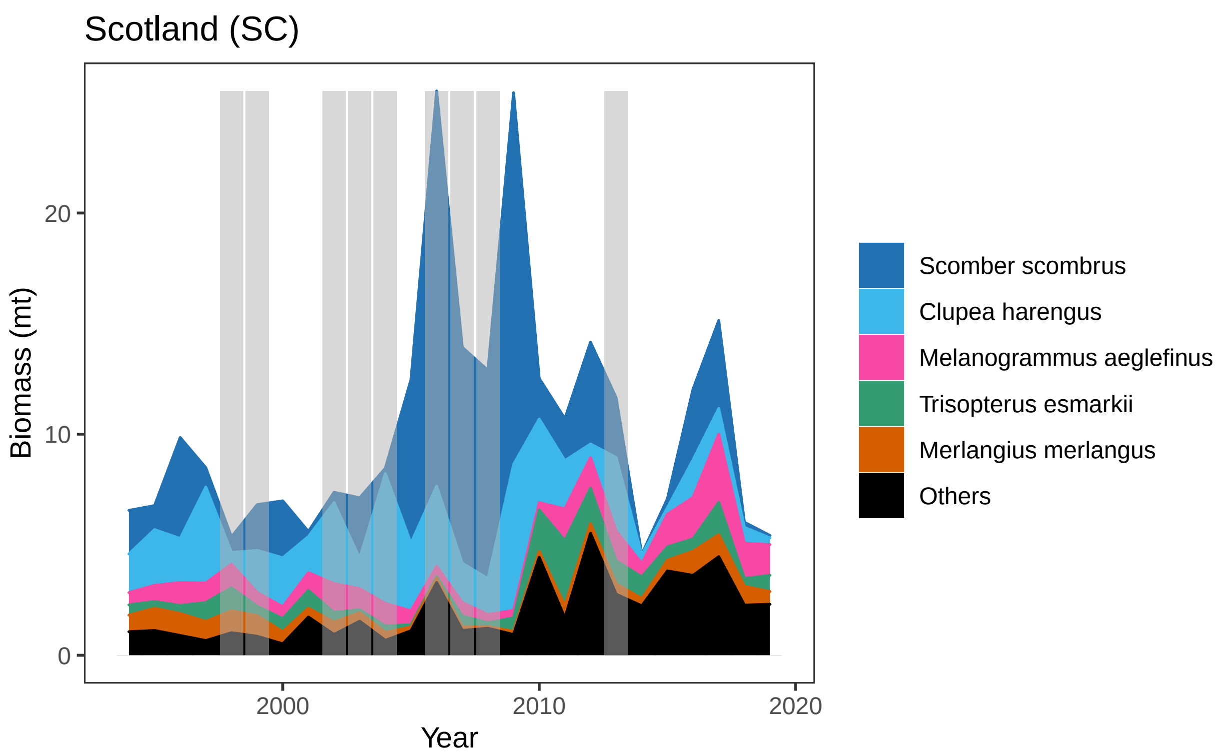
Supplementary Figure 35: Biomass trends and historical MHWs in a single region. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. The top five taxa by biomass are highlighted. Shaded grey rectangles denote when any MHWs occurred in the preceding survey-year.



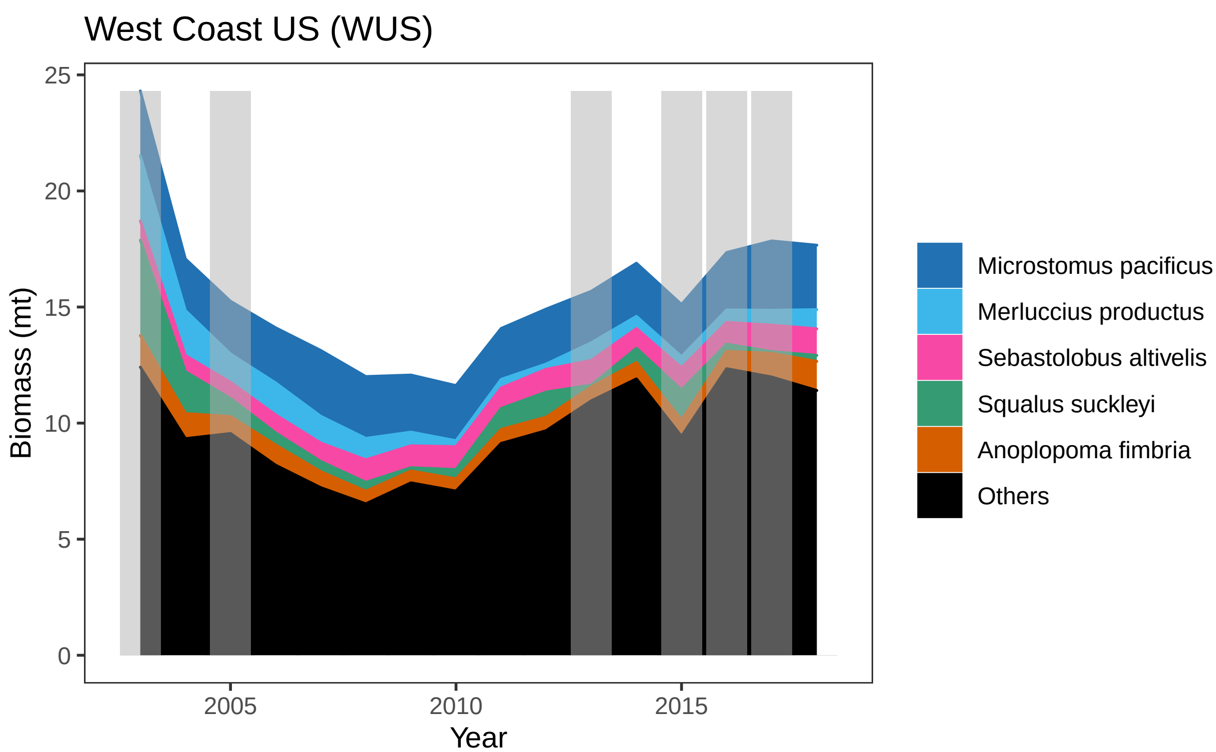
Supplementary Figure 36: Biomass trends and historical MHWs in a single region. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. The top five taxa by biomass are highlighted. Shaded grey rectangles denote when any MHWs occurred in the preceding survey-year.



Supplementary Figure 37: Biomass trends and historical MHWs in a single region. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. The top five taxa by biomass are highlighted. Shaded grey rectangles denote when any MHWs occurred in the preceding survey-year.



Supplementary Figure 38: Biomass trends and historical MHWs in a single region. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. The top five taxa by biomass are highlighted. Shaded grey rectangles denote when any MHWs occurred in the preceding survey-year.



Supplementary Figure 39: Biomass trends and historical MHWs in a single region. MHWs were calculated from the detrended GLORYS sea bottom temperature data with a five-day minimum duration threshold for MHWs, as used in the main text. The top five taxa by biomass are highlighted. Shaded grey rectangles denote when any MHWs occurred in the preceding survey-year.