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Supplementary Materials for

Atlantic Multidecadal Oscillations drive the basin-scale distribution of Atlantic bluefin tuna

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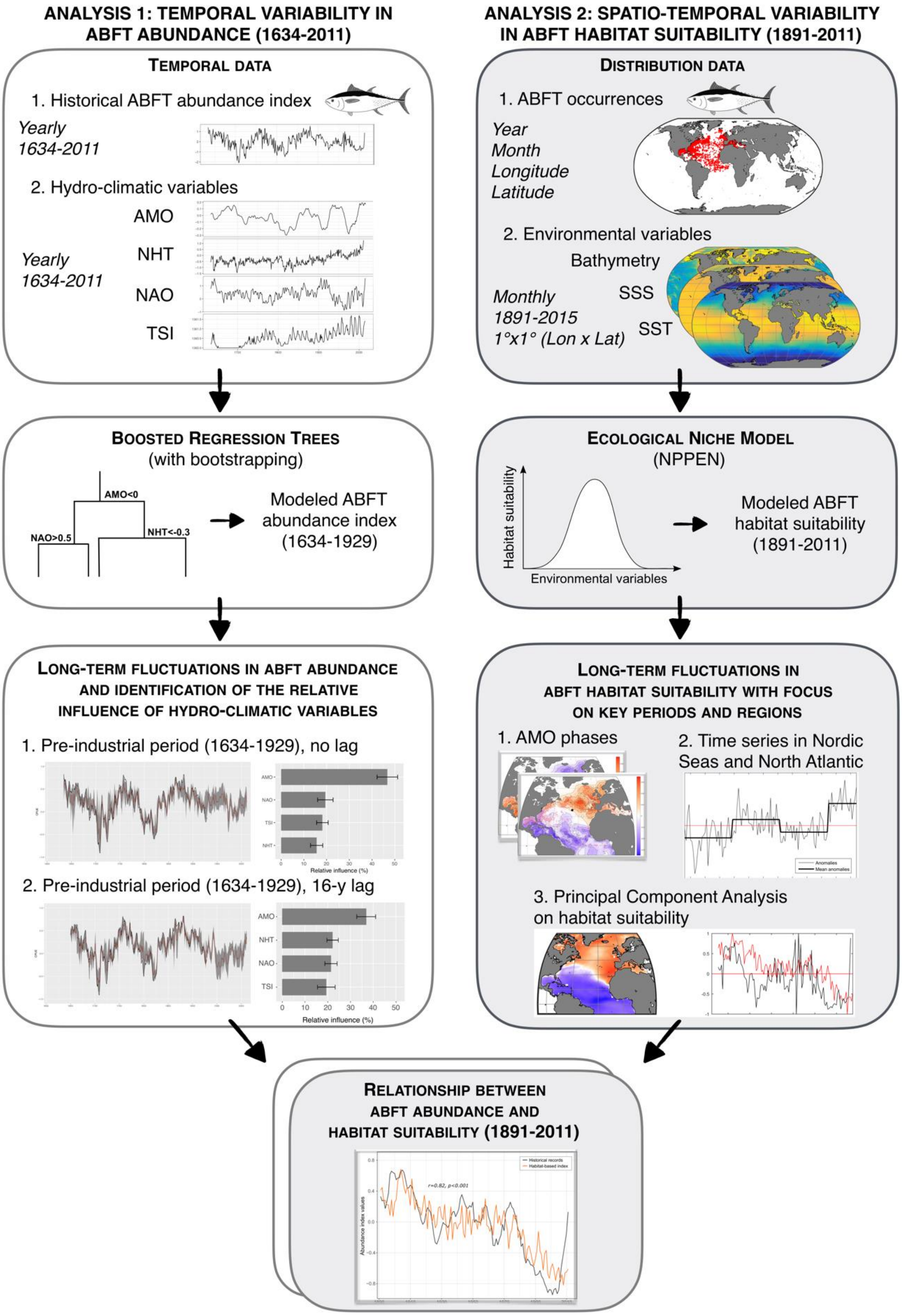

Fig. S1. Summary of the two-step analysis conducted in this study. ABFT: Atlantic bluefin tuna; AMO: Atlantic Multidecadal Oscillation; NHT: North Hemisphere Temperature anomalies; NAO: North Atlantic Oscillation; TSI: Total Solar Irradiance; SSS: Sea Surface Salinity; SST: Sea Surface Temperature; NPPEN: Non-Parametric Probabilistic Ecological Niche model.

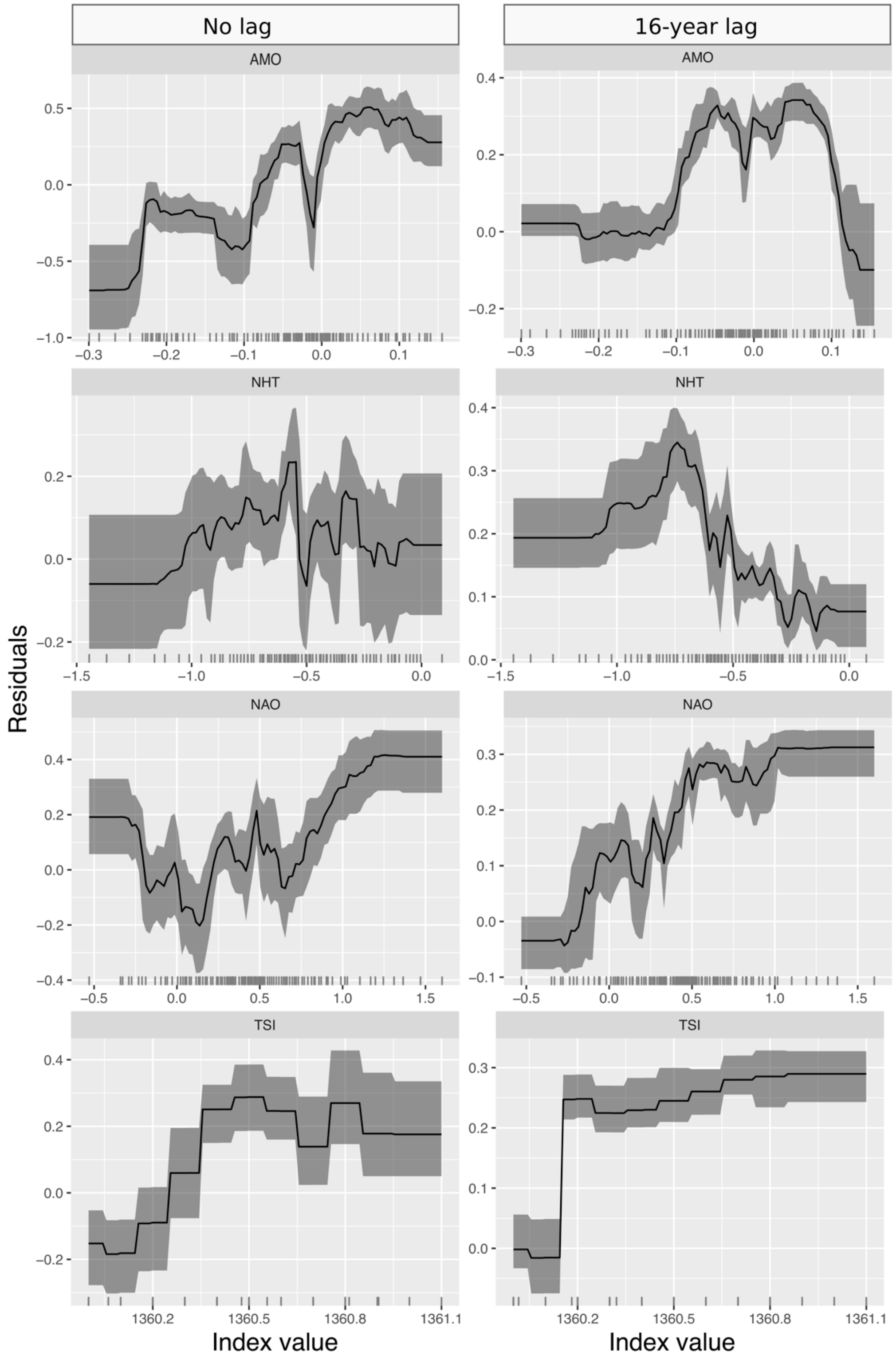

Fig. S2. Relationships between each hydroclimatic index and the abundance of Atlantic bluefin tuna, presented as the residuals from the BRT models for the pre-industrial period (1634-1929), for the adult abundance (left) and with the inclusion of a one-generation lag (16 years) in the time series (right). The black line indicates the mean; the shaded area indicates the 5% and 95% confidence intervals.

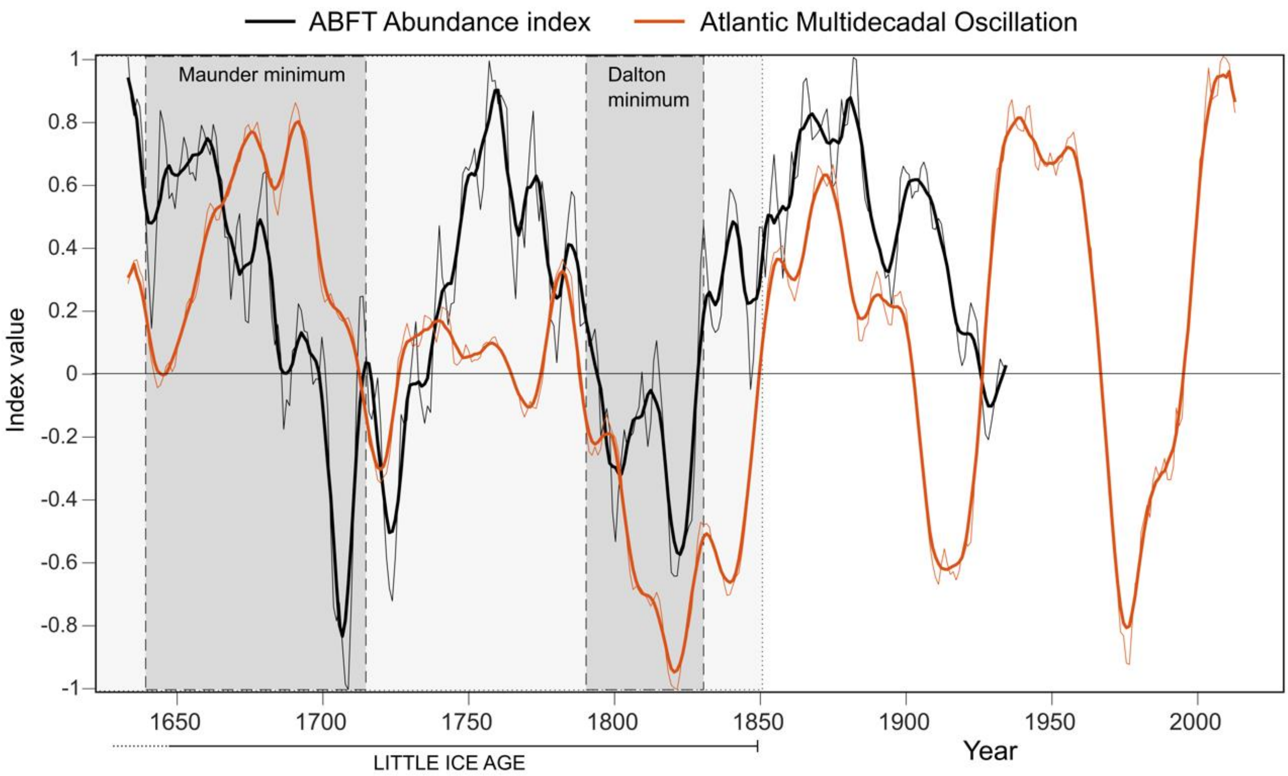

Fig. S3. Long-term changes in the Atlantic Multidecadal Oscillation and in the abundance of eastern Atlantic bluefin tuna. A 5-year moving average was applied on both indices (bluefin tuna abundance index in black and AMO index in orange). Cold climatic phases at the end of the Little Ice Age characterised by low TSI values (i.e. the Maunder and the Dalton minimums) are indicated.

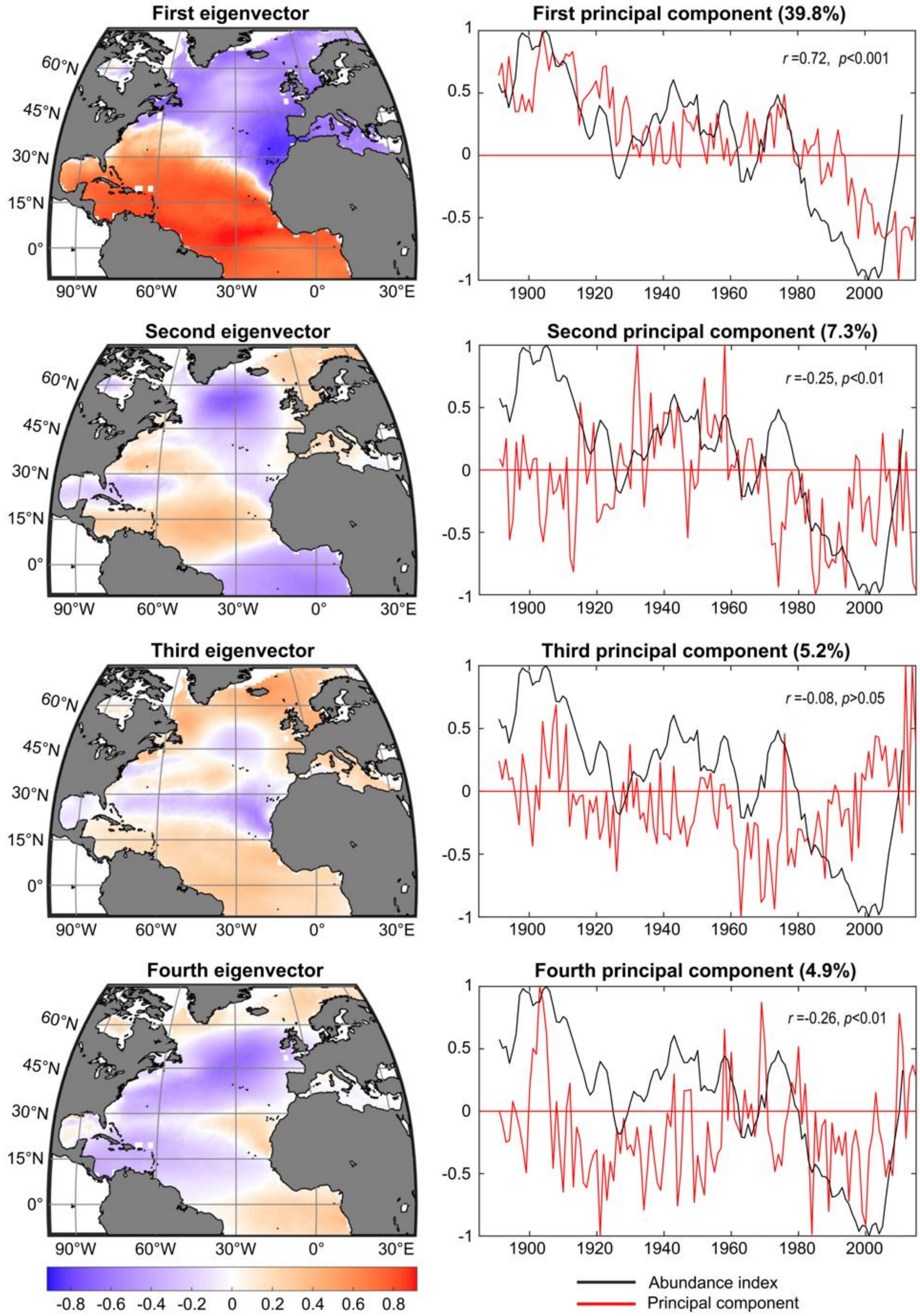

Fig. S4. Spatiotemporal variability in the habitat suitability of Atlantic bluefin tuna. Mapping of the first four eigenvectors and long-term changes (1891-2011) in the first four principal components calculated from the PCA performed on habitat suitability of Atlantic bluefin tuna. The total explained variability is given for each principal component as well as correlation values with the tuna abundance index.

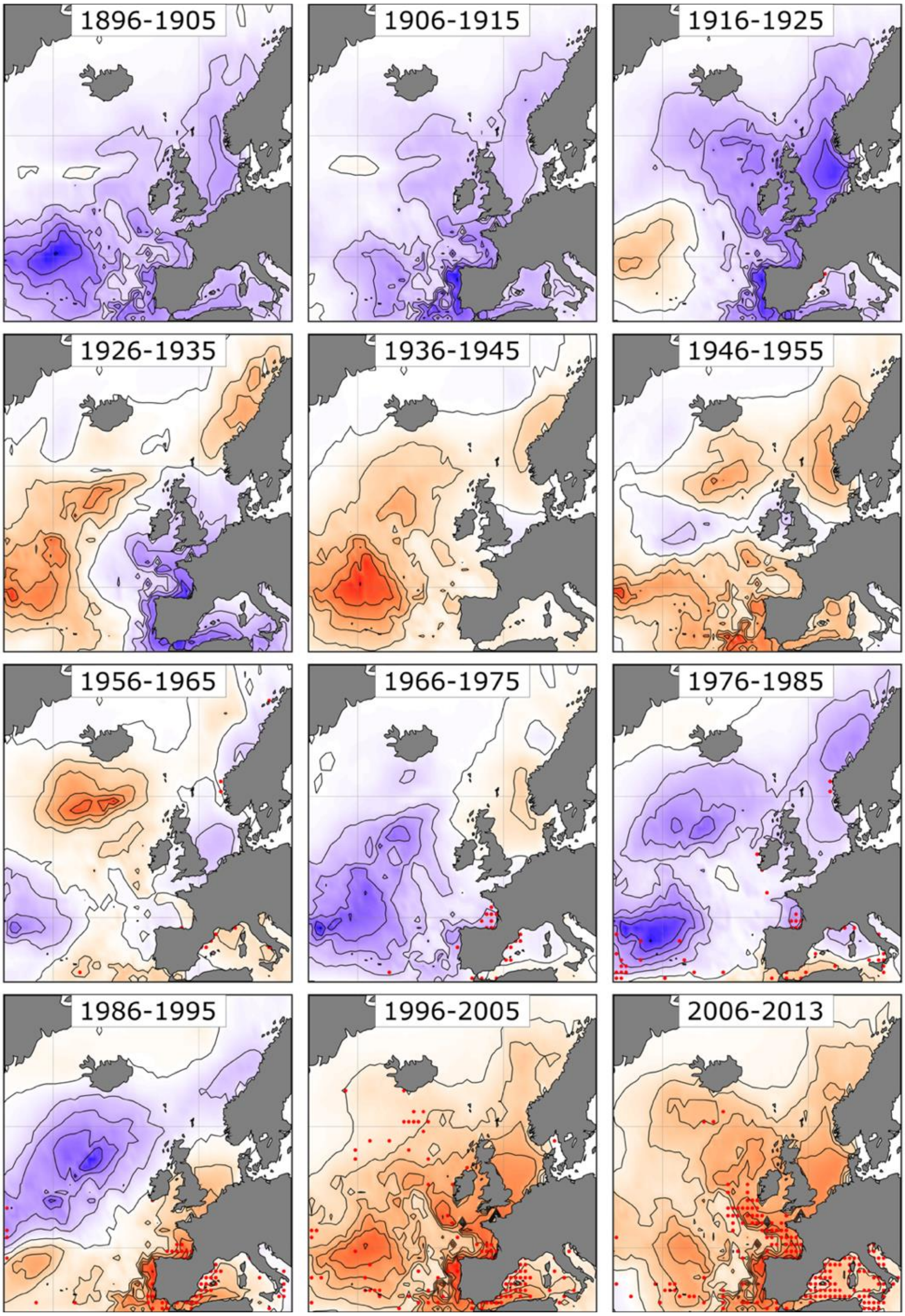

Fig. S5. Decadal monthly anomalies of habitat suitability of Atlantic bluefin tuna in the NE Atlantic. Negative anomalies are in purple and positive anomalies are in orange. For visual representation, the colour scale was adjusted separately for each panel. Red dots: Species occurrences (per 1°x1° geographical cell).

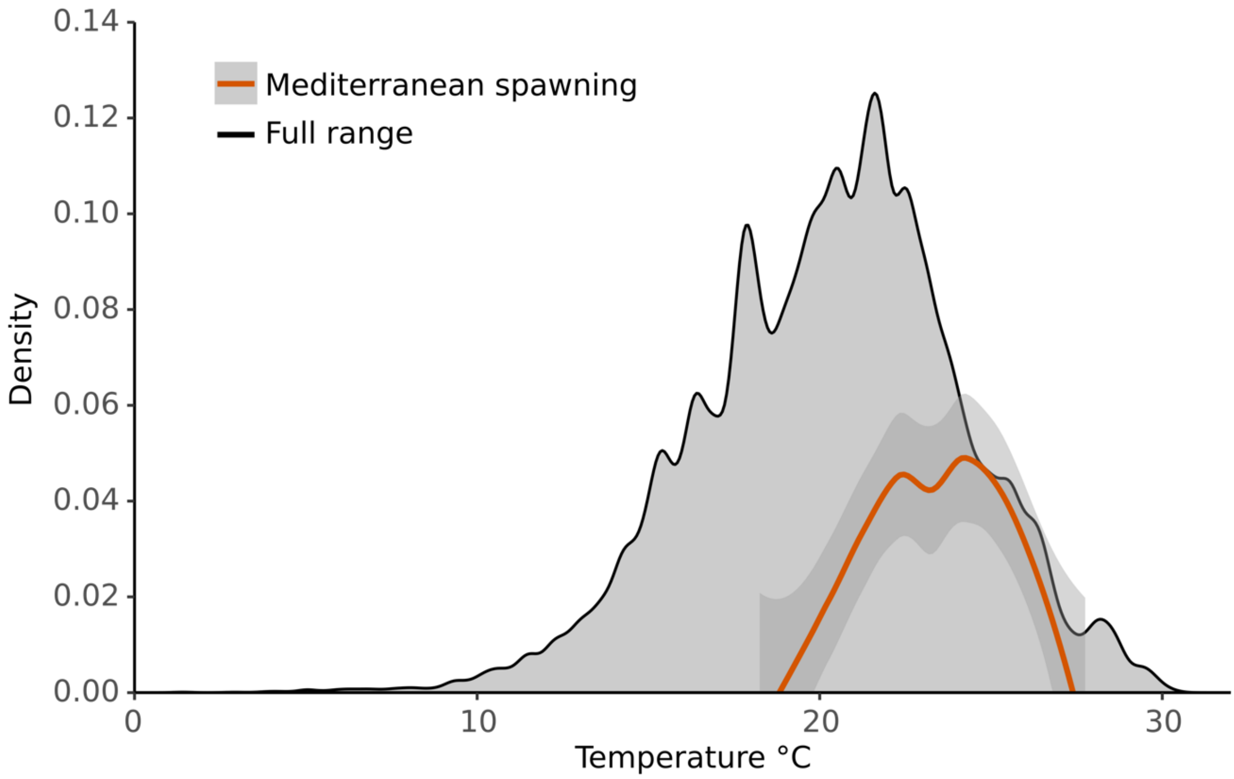

Fig. S6. Thermal niche of Atlantic bluefin tuna. Realised thermal niches for the species' entire distribution range (in grey) and for the Mediterranean Sea only (in orange) during the spawning period June-August (the shaded area represents the 95% confidence interval).

Table S1. Influence of tree complexity and bagging fraction on the performance of the Boosted Regression Tree models. Parameters (mean and standard deviation; SD) retained for the final models are in bold (combination of lowest deviance, highest cross-validation correlation coefficient (CV) and highest R^2_{adj}).

Tree complexity	1	2	3	4	5	6	7	8	**9**	10	11	12
Deviance	0.097	0.085	0.081	0.078	0.076	0.074	0.074	0.073	**0.073**	0.073	0.072	0.073
SD	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002	**0.002**	0.002	0.002	0.002
CV	0.582	0.65	0.667	0.68	0.692	0.699	0.7	0.703	**0.706**	0.703	0.707	0.707
SD	0.009	0.01	0.011	0.012	0.01	0.012	0.012	0.012	**0.01**	0.014	0.014	0.012
R^2_{adj}	0.42	0.585	0.676	0.74	0.783	0.813	0.828	0.842	**0.852**	0.861	0.876	0.884
SD	0	0.001	0	0.001	0.006	0.007	0.015	0.015	**0.013**	0.017	0.019	0.012
Bagging fraction	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	**0.80**	0.85	0.90	0.95
Deviance	0.074	0.073	0.074	0.073	0.073	0.073	0.073	0.073	**0.073**	0.073	0.074	0.074
SD	0.002	0.002	0.002	0.002	0.001	0.002	0.002	0.002	**0.002**	0.003	0.002	0.002
CV	0.699	0.702	0.7	0.703	0.705	0.707	0.704	0.705	**0.707**	0.702	0.701	0.701
SD	0.01	0.012	0.01	0.014	0.011	0.01	0.012	0.014	**0.011**	0.015	0.01	0.014
R^2_{adj}	0.826	0.836	0.841	0.844	0.846	0.85	0.854	0.858	**0.86**	0.856	0.856	0.854
SD	0.011	0.011	0.015	0.013	0.015	0.015	0.016	0.017	**0.016**	0.018	0.017	0.02

Table S2. Effects of different combinations of environmental variables and of different thresholds of occurrence on the performance of the NPPEN model applied on Atlantic bluefin tuna. The performance of the model was assessed by means of the Continuous Boyce Index (mean CBI and standard deviation; see Materials and Methods). The combination of environmental variables and the required number of occurrence we retained are in bold. SST: Sea Surface Temperature; SSS: Sea Surface Salinity; BAT: Bathymetry; SD: standard deviation.

Environmental variables	CBI	SD
SST	0.786	0.114
SSS	0.023	0.260
BAT	-0.173	0.177
SST+SSS	0.789	0.093
SST+BAT	0.806	0.125
BAT+SSS	0.303	0.390
SST+SSS+BAT	**0.835**	**0.092**
Thresholds of occurrence per set of environmental conditions		
1	**0.835**	**0.092**
2	0.804	0.132
3	0.771	0.155
5	0.649	0.224
10	0.703	0.319