Oikos

OIK-07332
Tanner, S. E., Giacomello, E., Menezes, G. M., Mirasole, A., Neves, J., Sequeira, V., Vasconcelos, R. P., Vieira, A. R. and Morrongiello, J. R. 2020. Marine regime shifts impact synchrony of deep-sea fish growth in the Northeast Atlantic. – Oikos doi: 10.1111/oik.07332

Supplementary material

Appendix 1.

a) b)

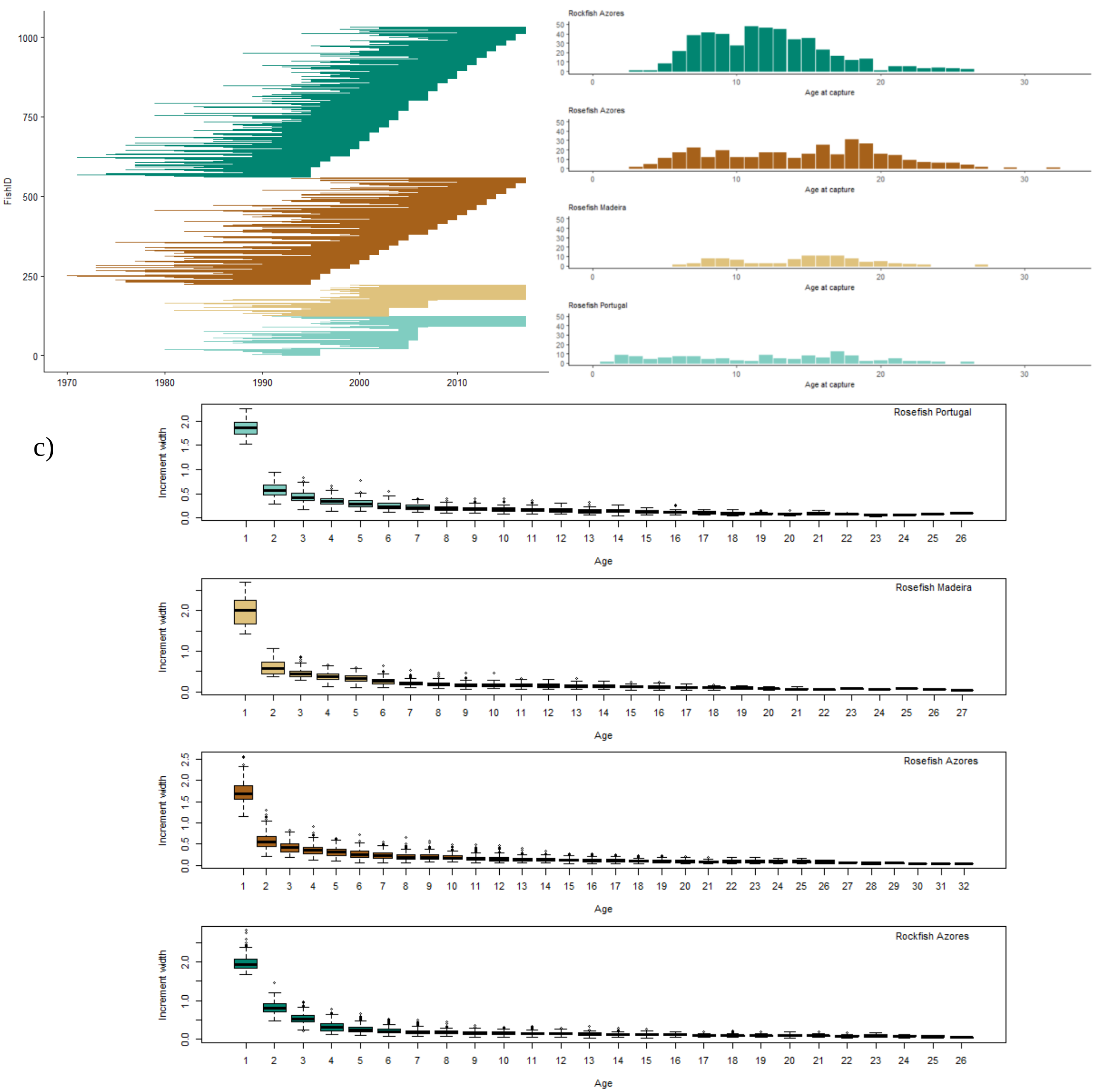
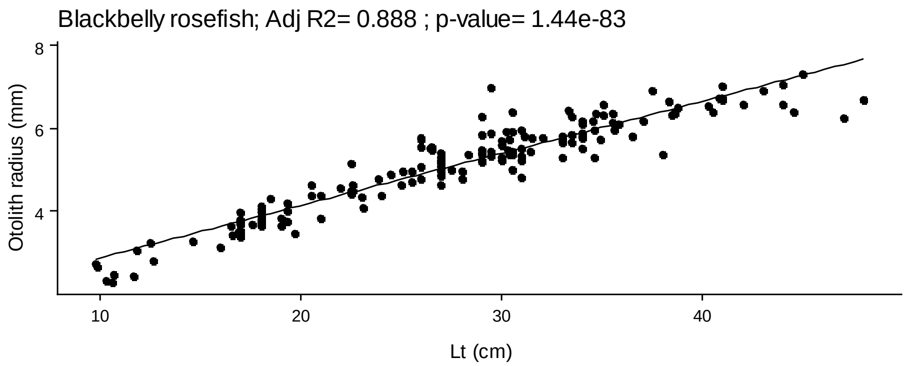


Fig. A1. a) Temporal range of fish samples used in study, each line representing an individual sample. b) Age at capture frequency distribution of the different datasets. c) Box-and-whiskers plot of annual increment measurements with lines, boxes, and whiskers representing medians, interquartile range (IQR), and 1.5 IQR, respectively. Circles represent outliers. Aqua=rosefish Portugal, beige=rosefish Madeira, brown=rosefish Azores and turquoise=rockfish Azores. Azores samples were collected during several survey cruises (1996-97 co-financed by the European

Commission, Study contracts 94/034 and 95/05 EU DG-XIV; since 1998 financed by the Azores Regional Government, Monitorização Anual das Abundâncias de Espécies Demersais e de Profundidade nos Açores).

a)



b)

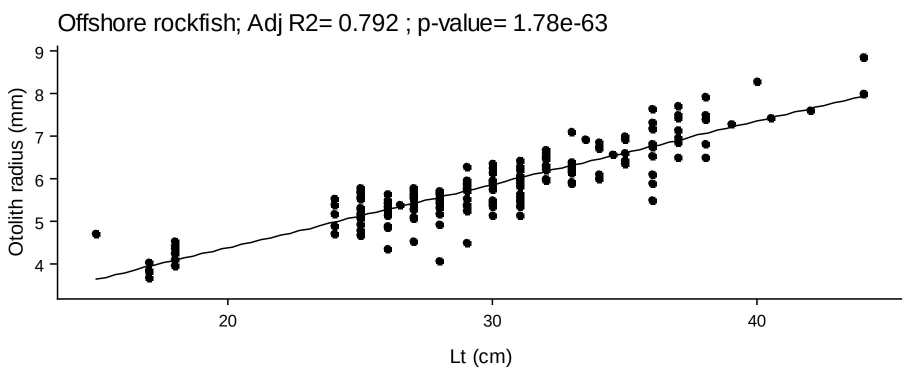


Figure A2. Relationship between total length and otolith radius of a) rosefish and b) rockfish based on randomly selected subsets of 173 and 182 samples, respectively. Adjusted R-squared and p-values are also shown.

Table A1. Results of random effect and fixed effect model optimisation of rosefish location model. The best supported model, based on ΔAICc, is highlighted in bold. Random Age slopes for variables are denoted by "Age|variable". df=degrees of freedom, ΔAICc = difference in AICc between a particular model and the model with the lowest AICc, wAICc=Akaike weights.

Rosefish location model					
Random effect structure					
Random intercept	Random slope	df	AICc	ΔAICc	wAICc
FishID, Location:Year		18	4549.1	638.4	<0.001
FishID, Location:Year	Age|FishID	20	3917.2	6.5	0.029
FishID, Location:Year	Age|Location:Year	20	4536.4	625.7	<0.001
FishID, Location:Year, Location:Cohort		19	4549.0	638.3	<0.001
FishID, Location:Year, Location:Cohort	**Age|FishID**	**21**	**3910.7**	**0.0**	**0.757**
FishID, Location:Year, Location:Cohort	Age|Location:Cohort	23	3913.2	2.5	0.213

Fixed effect structure				
Terms	df	AICc	ΔAICc	wAICc
Age	8	3833.7	17.2	<0.001
Age + Sex	9	3831.1	14.6	<0.001
Age + AAC	9	3835.5	19.0	<0.001
Age * Sex	10	3833.1	16.6	<0.001
Age + AAC +Sex	10	3833.1	16.6	<0.001
Age + location	10	3834.4	17.9	<0.001
Age + Sex + location	11	3832.0	15.5	<0.001
Age * Sex + AAC	11	3835.0	18.5	<0.001
Age + AAC + location	11	3836.3	19.8	<0.001
Age * location	12	3828.4	11.9	<0.001
Age * Sex + location	12	3834.0	17.5	<0.001
Age + AAC + Sex + location	12	3834.0	17.5	<0.001
Age * location + Sex	13	3826.2	9.7	0.004
Age + location*Sex	13	3827.6	11.1	0.002
Age + AAC*location	13	3829.4	12.9	<0.001
Age * location + AAC	13	3830.4	13.9	<0.001
Age * Sex + AAC + location	13	3836.0	19.5	<0.001
Age + AAC * location + Sex	14	3827.0	10.5	0.003
Age * location + AAC + Sex	14	3828.2	11.7	0.002
Age* Sex + Age * location	14	3828.2	11.7	0.002
Age + AAC + Sex * location	14	3829.6	13.1	<0.001
Age*Sex + Sex*location	14	3829.6	13.1	<0.001
Age*location + Sex*location	15	3821.8	5.3	0.037
Age*location + AAC*location	15	3822.9	6.4	0.022
Age*Sex + AAC*location	15	3829.0	12.5	0.001
Age*Sex + Age*location + AAC	15	3830.2	13.7	<0.001
Age*Sex + AAC + Sex*location	15	3831.5	15.0	<0.001
Age*location + AAC*location + Sex	16	3820.5	4.0	0.071
Age + AAC*location + Sex*location	16	3823.0	6.5	0.020
Age*Sex + Age*location + Sex*location	16	3823.8	7.3	0.014
Age*location + AAC + Sex*location	16	3823.8	7.3	0.014
Age*Sex + Age*location + AAC*location	17	3822.5	6.0	0.026
Age*Sex + AAC*location + Sex*location	17	3825.0	8.5	0.008
Age*Sex + Age*location + AAC + Sex*location	17	3825.8	9.3	0.005
Age*location + AAC*location + Sex*location	**18**	**3816.5**	**0**	**0.530**
Age*Sex*location	18	3827.3	10.8	0.002
Age*Sex + Age*location + AAC*location + Sex*location	19	3818.5	2.0	0.194
Age*Sex*location + AAC	19	3829.3	12.8	<0.001
Age*Sex*location + AAC*location	21	3821.8	5.3	0.036

Table A2. Results of random effect and fixed effect model optimisation of Azores species model. The best supported model, based on ΔAICc, is highlighted in bold. Random Age slopes for variables are denoted by "Age|variable". df=degrees of freedom, ΔAICc = difference in AICc between a particular model and the model with the lowest AICc, wAICc=Akaike weights.

Azores species model					
Random effect structure					
Random intercept	Random slope	df	AICc	ΔAICc	wAICc
FishID, Species:Year		9	14072.9	688.0	<0.001
FishID, Species:Year	**Age|FishID**	**9**	**13384.9**	**0.0**	**1.0**
FishID, Species:Year, Species:Cohort		5	14074.5	689.6	<0.001

Fixed effect structure				
Terms	df	AICc	ΔAICc	wAICc
Age*species	9	13342.4	8.0	0.009
Age*species + Sex	10	13341.3	7.0	0.015
Age*species + AAC	10	13343.5	9.1	0.005
Age*species + Sex*species	11	**13334.4**	**0**	**0.504**
Age*species + AAC + Sex	11	13342.0	7.6	0.011
Age*species + AAC*species	11	13345.	11.0	0.002
Age*species + AAC + Sex*species	12	13335.3	0.9	0.326
Age*species + AAC*species + Sex	12	13343.7	9.3	0.004
Age*species + AAC*species + Sex*species	13	13337.2	2.8	0.121

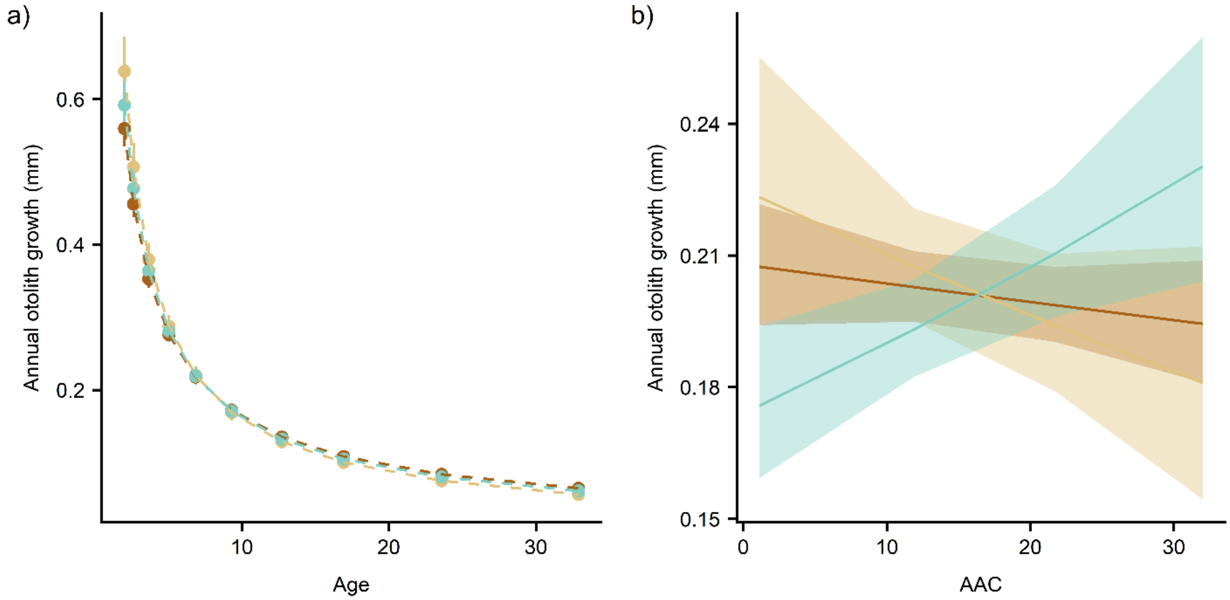


Fig A3. Annual mean otolith increment of rosefish collected in Azores (brown), Madeira (beige) and Portugal (aqua) by a) age and b) age-at-capture (AAC). Vertical lines in a) and shaded area in b) denote ±95% CI.

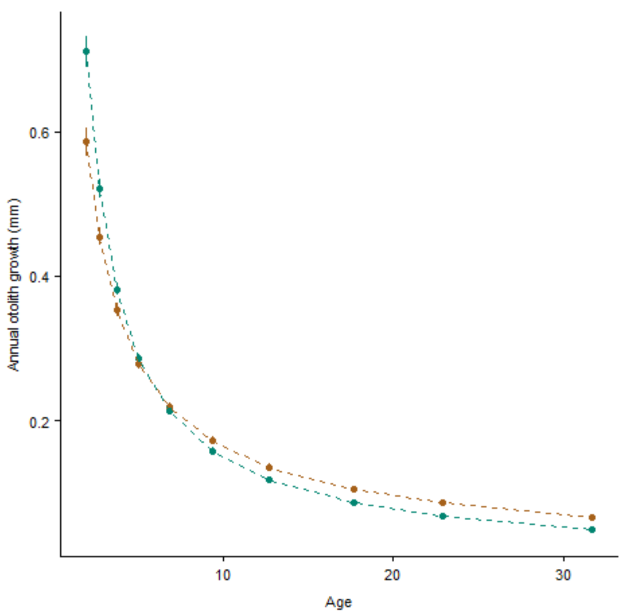


Fig A4. Annual mean otolith increment of rosefish (brown) and rockfish (turquoise) collected in Azores by age. Vertical lines denote ±95% CI.

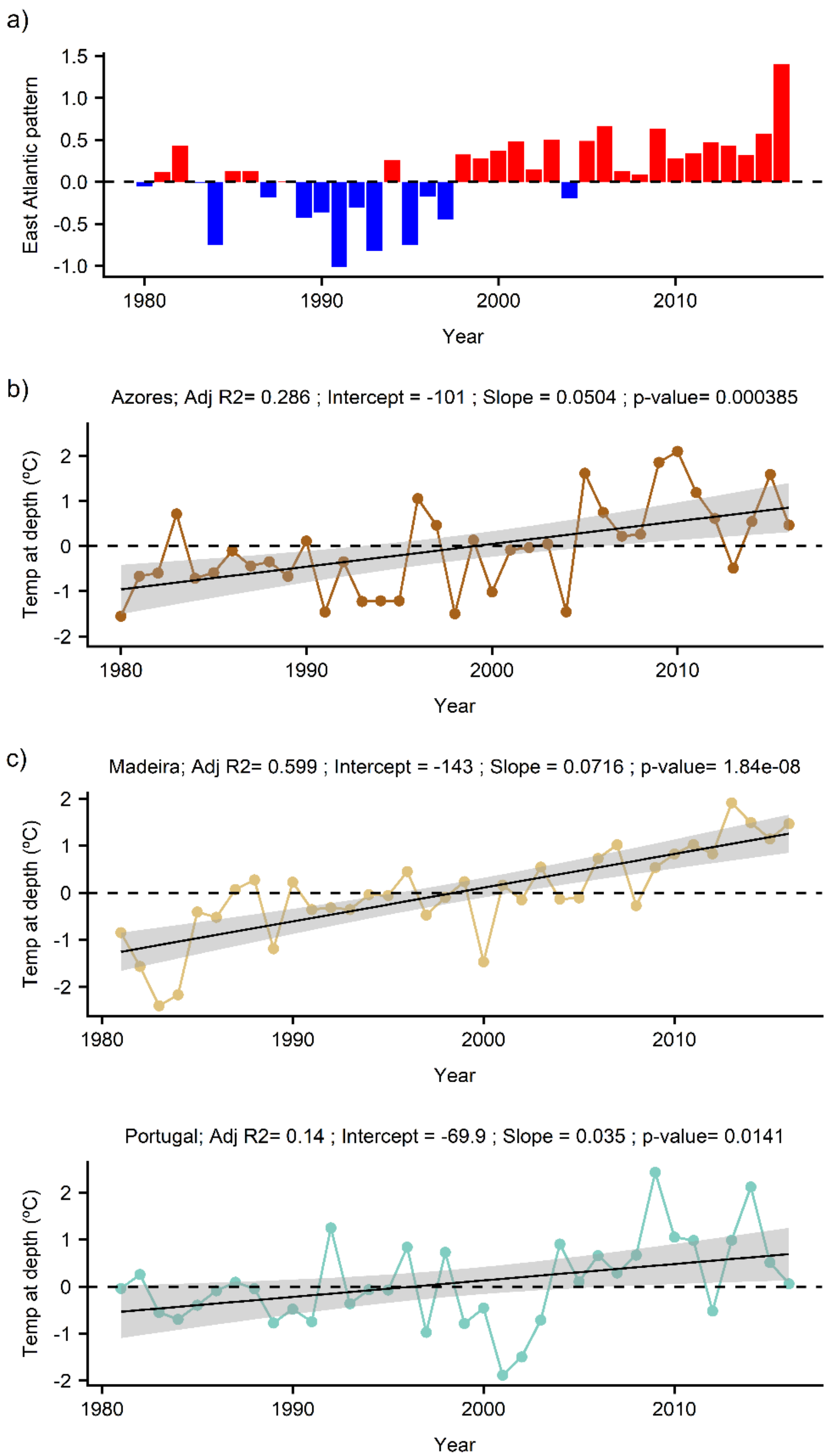


Fig. A5 Interannual variation of a) EAP (May-October) and temperature at depth (January-March) in b) Azores, c) Madeira and d) Portugal. These time windows were identified for the rosefish location dataset using the sliding window approach. Using the raw annual mean values (not scaled) of temperature at depth from January-March, we calculated the coefficient of variation (CV) for each location. CV_{Azores}=2.61%, $CV_{Madeira}$=1.81%, $CV_{Portugal}$=2.41%.

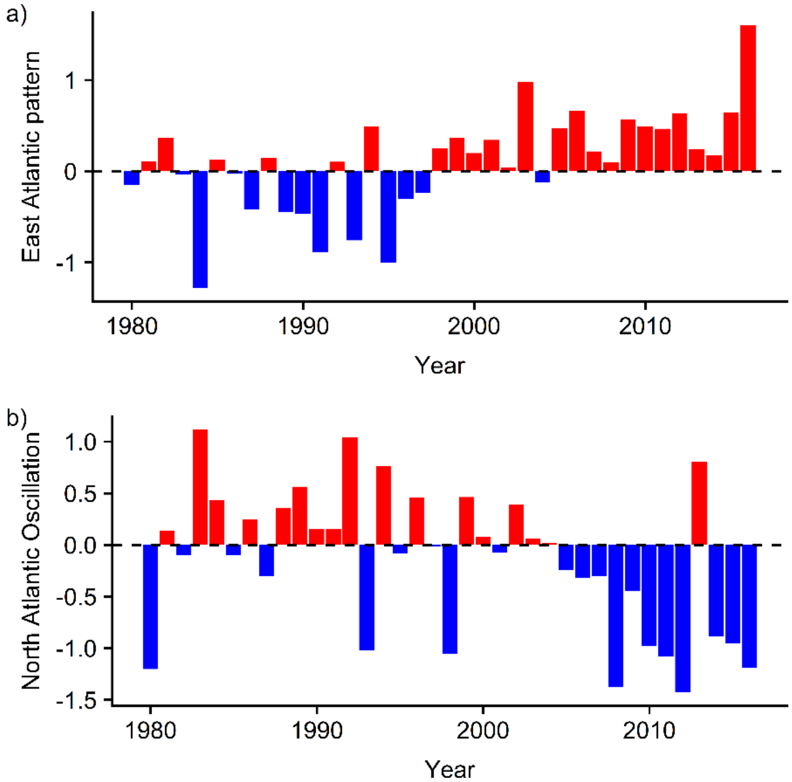


Fig. A6 Interannual variation of a) EAP (May-September) and b) NAO (May-August). These time windows were identified for the Azores species dataset using the sliding window approach.

Table A3. Results of sliding-window analysis for rosefish location model. Environmental predictors (Temp = Temperature at depth, NAO = North Atlantic Oscillation and EAP = East Atlantic pattern) were added as fixed effects to the best intrinsic model (IM; see Table A1) with varying absolute time windows. Models were fitted to the data from 1980-2016. Interaction terms are denoted by *. ΔAICc = difference in AICc between a particular model and the model with the lowest AICc; window open/close = month of identified optimal window open/close.

First step of sliding window analysis

Model	ΔAICc	W open	W close	p-value
IM	17.46	-	-	-
IM + Temp	16.21	Nov	Nov	-
IM + NAO	11.38	Jul	Oct	-
IM + EAP	**0.00**	**May**	Oct	**0.003**
IM + Age*Temp	18.01	Nov	Nov	-
IM + Age*NAO	13.24	Jul	Oct	-
IM + Age*EAP	0.04	May	Oct	-
IM + Location*Temp	17.78	Feb	Feb	-
IM + Location*NAO	14.10	Jul	Oct	-
IM + Location*EAP	2.48	May	Oct	-
IM + Age* Location *Temp	14.25	Mar	Mar	-
IM + Age* Location *NAO	18.53	Jul	Aug	-
IM + Age* Location *EAP	4.36	May	Oct	-

Second step of sliding window analysis

Model	ΔAICc	W open	W close	p-value
IM + Age* EAP	7.84	-	-	-
IM + Age* EAP + Temp	7.61	Nov	Nov	-
IM + Age* EAP + NAO	6.71	Feb	Feb	-
IM + Age* EAP + Age*Temp	9.59	Nov	Nov	-
IM + Age* EAP + Age*NAO	5.94	May	Aug	-
IM + Age* EAP + Location *Temp	-4.42	Feb	Feb	-
IM + Age* EAP + Location *NAO	-1.91	May	Jul	-
IM + Age* EAP + Age* Location *Temp	**0.00**	**Jan**	**Mar**	**0.039**
IM + Age* EAP + Age* Location *NAO	8.39	May	Jul	-

Third step of sliding window analysis

Model	ΔAICc	W open	W close	p-value
IM + Age* EAP + Age* Location *Temp	4.46	-	-	-
IM + Age* EAP + Age* Location *Temp + NAO	3.06	Feb	Feb	>0.05
IM + Age* EAP + Age* Location *Temp + Age*NAO	3.60	May	Jul	>0.05
IM + Age* EAP + Age* Location *Temp + Location*NAO	0.00	May	Jul	>0.05
IM + Age* EAP + Age* Location *Temp + Age*Location*NAO	2.33	May	Jul	>0.05

Table A4. Results of sliding-window analysis for Azores species model. Environmental predictors (Temp = Temperature at depth, NAO = North Atlantic Oscillation and EAP = East Atlantic pattern) were added as fixed effects to the best intrinsic model (IM; see Table A2) with varying absolute time windows. Models were fitted to the data from 1980-2016. Interaction terms are denoted by *. ΔAICc = difference in AICc between a particular model and the model with the lowest AICc; W open/close = month of identified optimal window open/close.

First step of sliding window analysis				
Model	ΔAICc	W open	W close	p-value
IM	46.64	-	-	-
IM + Temp	48.08	Dec	Dec	-
IM + NAO	46.80	Feb	Feb	-
IM + EAP	45.11	May	Jun	-
IM + Age*Temp	38.63	May	Dec	-
IM + Age*NAO	28.68	Aug	Aug	-
IM + Age*EAP	39.67	Jun	Sep	-
IM + Species*Temp	49.17	Aug	Aug	-
IM + Species*NAO	40.95	Jun	Oct	-
IM + Species*EAP	31.14	Jan	Nov	-
IM + Age*Species*Temp	17.04	Jun	Jun	-
IM + Age*Species*NAO	9.93	Jul	Aug	-
IM + Age*Species*EAP	**0.00**	May	Sep	**0.024**

Second step of sliding window analysis				
Model	ΔAICc	W open	W close	p-value
IM + Age*Species*EAP	28.28	-	-	-
IM + Age*Species*EAP + Temp	29.32	Jun	Jun	-
IM + Age*Species*EAP + NAO	27.33	Feb	Feb	-
IM + Age*Species*EAP + Age*Temp	21.07	Jan	Oct	-
IM + Age*Species*EAP + Age*NAO	**10.40**	May	Aug	**0.049**
IM + Age*Species*EAP + Species*Temp	29.27	Feb	Feb	-
IM + Age*Species*EAP + Species*NAO	23.42	May	Jul	-
IM + Age*Species*EAP + Age*Species*Temp	12.30	May	Oct	-
IM + Age*Species*EAP + Age*Species*NAO	0.00	May	Aug	>0.05

Third step of sliding window analysis				
Model	ΔAICc	W open	W close	p-value
IM + Age*Species*EAP + Age*NAO	0.68	-	-	-
IM + Age*Species*EAP + Age*NAO + Temp	0.65	Jan	Jan	>0.05
IM + Age*Species*EAP + Age*NAO + Age*Temp	0.00	Apr	Apr	>0.05
IM + Age*Species*EAP + Age*NAO + Species*Temp	2.17	Jan	Jan	-
IM + Age*Species*EAP + Age*NAO + Age*Species*Temp	3.27	Feb	Apr	-