Table S1. Top 76 proportionally present species in the bi-annual bottom trawl surveys from 1969 to 2019 of the Northeast United States Large Marine Ecosystem. The threshold for inclusion was comprising at least 0.01% of biomass across all surveys in all ecological production units.

Common Name	Scientific Name	Common Name	Scientific Name
Dusky shark	*Carcharhinus obscurus*	Windowpane	*Scophthalmus aquosus*
Roughtail stingray	*Dasyatis centroura*	John dory	*Zenopsis conchifera*
Basking shark	*Cetorhinus maximus*	Atlantic mackerel	*Scomber scombrus*
Sandbar shark	*Carcharhinus plumbeus*	Chub mackerel	*Scomber japonicus*
Smooth dogfish	*Mustelus canis*	Butterfish	*Peprilus triacanthus*
Chain dogfish	*Scyliorhinus retifer*	Bluefish	*Pomatomus saltatrix*
Spiny dogfish	*Squalus acanthias*	Atlantic croaker	*Micropogonias undulatus*
Atlantic angel shark	*Squatina dumeril*	Striped bass	*Morone saxatilis*
Bluntnose stingray	*Dasyatis say*	Black sea bass	*Centropristis striata*
Bullnose ray	*Myliobatis freminvillei*	Scup	*Stenotomus chrysops*
Barndoor skate	*Dipturus laevis*	Weakfish	*Cynoscion regalis*
Winter skate	*Leucoraja ocellata*	Spot	*Leiostomus xanthurus*
Clearnose skate	*Raja eglanteria*	Acadian redfish	*Sebastes fasciatus*
Rosette skate	*Leucoraja garmani*	Blackbelly rosefish	*Helicolenus dactylopterus*
Little skate	*Leucoraja erinacea*	Longhorn sculpin	*Myoxocephalus octodecemspinosus*
Smooth skate	*Malacoraja senta*	Sea raven	*Hemitripterus americanus*
Thorny skate	*Amblyraja radiata*	Northern searobin	*Prionotus carolinus*
Southern stingray	*Dasyatis americana*	Atlantic wolffish	*Anarhichas lupus*
Round herring	*Etrumeus teres*	Ocean pout	*Macrozoarces americanus*
Atlantic herring	*Clupea harengus*	Fawn cusk-eel	*Lepophidium profundorum*
Alewife	*Alosa sapidissima*	Goosefish	*Lophius americanus*

Striped anchovy	*Anchoa hepsetus*	Beardfish	*Polymixia lowei*
Offshore hake	*Merluccius albidus*	Ocean sunfish	*Polymixia nobilis*
Silver hake	*Merluccius bilinearis*	Cownose ray	*Rhinoptera bonasus*
Atlantic cod	*Gads morhua*	American lobster	*Homarus americanus*
Haddock	*Melanogrammus aeglefinus*	Shrimp uncl	*Crustacea shrimp*
Pollock	*Pollachius virens*	Northern shrimp	*Pandalus borealis*
White hake	*Urophycis tenuis*	Atlantic rock crab	*Cancer irroratus*
Red hake	*Urophycis chuss*	Horseshoe crab	*Limulus polyphemus*
Spotted hake	*Urophycis regia*	Coarsehand lady crab	*Ovalipes stephensoni*
Cusk	*Brosme brosme*	Atlantic sharpnose shark	*Rhizoprionodon terraenovae*
Atlantic halibut	*Hippoglossus hippoglossus*	Spiny butterfly ray	*Gymnura altavela*
American plaice	*Hippoglossoides platessoides*	Southern eagle ray	*Myliobatis goodei*
Summer flounder	*Paralichthys dentatus*	Sea scallop	*Placopecten magellanicus*
Fourspot flounder	*Hippoglossina oblongus*	Northern shortfin squid	*Illex illecebrosus*
Yellowtail flounder	*Limanda ferruginea*	Longfin squid	*Loligo pealeii*
Winter flounder	*Pseudopleuronectes americanus*	Cobia	*Rachycentron canadum*
Witch flounder	*Glyptocephalus cynoglossus*	Loggerhead seaturtle	*Caretta caretta*

Table S2. Model selection results for each ecological production unit using forward stepwise model selection. The final model is the most conservative model that captures significant dynamics. In all three ecological production units model selection selected ecosystem overfishing as one of their significant variables to include. Degrees of freedom for each model =1. Bolded values highlight AIC values considered in the model selection. Black boxes highlight the most parsimonious model.

Ecological Production Units	Variable	AIC	*F*-statistic	p-value
GOM	(+ Fogarty)	**-77.415**	5.2736	0.005
GOM	(+ MHW CI)	-75.859	3.6123	0.005
GOM	(+ Mean GSI)	-74.092	1.8105	0.045
GOM	(+ BT Anomalies)	-73.914	1.6337	0.145
GOM	(+ S:L Zooplankton)	-73.765	1.4874	0.185
GOM	(+ Fogarty + MHW CI)	**-77.257**	1.7327	0.07
GOM	(+ Fogarty + Mean GSI)	**-77.111**	1.5916	0.155
GOM	(+ Fogarty + S:L Zooplankton	**-76.602**	1.106	0.345
GOM	(+ Fogarty + BT Anomalies)	**-76.274**	0.797	0.55
GB	(+ Mean GSI)	**-85.288**	5.1882	0.05
GB	(+ MHW CI)	**-84.845**	4.7091	0.01
GB	(+ Fogarty)	**-84.509**	4.3495	0.1
GB	(+ BT Anomaly)	-83.587	3.3792	0.01
GB	(+ S:L Zooplankton)	-81.218	0.999	0.425
GB	(+ Mean GSI + Fogarty)	**-85.577**	2.1667	0.045
GB	(+ Mean GSI + MHW CI)	**-85.606**	2.1951	0.06
GB	(+ Mean GSI + S:L Zooplankton)	**-84.808**	1.4228	0.225
GB	(+ Mean GSI + BT Anomaly)	-83.851	0.4913	0.8
GB	(+ Mean GSI + Fogarty + MHW CI)	**-85.731**	1.973	0.065
GB	(+ Mean GSI + Fogarty + S:L Zooplankton)	**-85.099**	1.3818	0.18
GB	(+ Mean GSI + Fogarty + BT Anomaly)	**-84.126**	0.4913	0.85
MAB	(+ Fogarty)	**-77.33**	2.5991	0.005
MAB	(+ MHW CI)	**-77.327**	2.5965	0.005
MAB	(+ Mean GSI)	**-76.644**	1.9092	0.015
MAB	(+ BT Anomaly)	**-76.093**	1.3637	0.115
MAB	(+ S:L Zooplankton)	**-75.719**	0.9982	0.46
MAB	(+ Fogarty + MHW CI)	**-77.696**	2.2423	0.005
MAB	(+ Fogarty + Mean GSI)	**-77.267**	1.8249	0.01
MAB	(+ Fogarty + BT Anomaly)	**-76.839**	1.413	0.085
MAB	(+ Fogarty + S:L Zooplankton)	**-76.435**	1.029	0.395
MAB	(+ Fogarty + MHW CI + BT Anomaly)	**-76.927**	1.1134	0.315
MAB	(+ Fogarty + MHW CI + S:L Zooplankton)	**-76.876**	1.0662	0.345
MAB	(+ Fogarty + MHW CI + Mean GSI)	**-76.714**	0.9174	0.61

Table S3. A comparison of full, marginal, and condition model effects with significance testing within each ecological production unit where more than one variable was selected using stepwise model selection. The significance of all three provides strong evidence that the predictors included in our model are indeed associated with the response variable, here species composition. It suggests that the model as a whole is meaningful and can effectively explain variation in community composition observations. The Gulf of Maine model selected for only the Fogarty ecosystem overfishing index as a significant covariate (Table S2) and is excluded here.

Ecological Production Unit	Source	df	Variance	*F*-statistic	p-value
Georges Bank	Global (Full) Model	2	0.018447	3.7665	0.001
Georges Bank	Fogarty Marginal Effect	1	0.011257	4.3495	0.005
Georges Bank	Mean Gulf Stream index Marginal Effect	1	0.013141	5.1882	0.001
Georges Bank	Fogarty Conditional Effect	1	0.005306	2.1667	0.037
Georges Bank	Mean Gulf Stream index Conditional Effect	1	0.007189	2.9359	0.016
Mid Atlantic Bight	Global (Full) Model	2	0.015047	2.4682	0.001
Mid Atlantic Bight	Fogarty Marginal Effect	1	0.008212	2.5991	0.001
Mid Atlantic Bight	Marine Heatwaves Marginal Effect	1	0.008204	2.5965	0.001
Mid Atlantic Bight	Fogarty Conditional Effect	1	0.006843	2.2449	0.002
Mid Atlantic Bight	Marine Heatwaves Conditional Effect	1	0.006835	2.2423	0.003

Text S1. Supplemental Methods

1.1 CROSS CORRELATION INTERPRETATION

We anticipated the significant magnitude of change in MHW events as pulse disturbances would correlate to higher trajectory lengths and angles suggesting a disruption of the community assemblage. This relationship would be expressed in a significant negative cross correlation exceeding threshold values. A negative cross correlation suggests MHW changes “lead” significant changes in trajectory lengths and angles. However, cross correlations were not found to be significant and did not exceed the threshold values of cross-correlations on a lag of up to 7 years. While comparison of cross correlation values requires a comparable number of study observations and time lags considered, Yoo et al. 2023 considered 0.75 to be a “strong” cross correlation, and described 0.51 as “moderate,” and found the moderate cross correlation to be insignificant with followup statistical testing. Our values do not approach these values and similarly do not significantly exceed the determined threshold values for each time lag (k = 0 to -7). To conclude the effect of MHWs was significant we would have observed a high correlation coefficient and significance, the former of which is not present in this study, so we do not see a significant relationship to report.

Table S4. Cross correlation outputs exploring the relationship between changes in marine heatwave cumulative intensity and community trajectory analysis beta diversity metrics of community change. There are no significant cross correlations observed within this analysis. The significance threshold is determined as 2 /sqrt(n -| k|) (Yoo et al. 2023). With n as the number of samples and k as the time lag. Lags up to 7 years are considered.

EPU	Lag	Threshold	CCA Trajectory Lengths	CCA Trajectory Angles
GOM	0	0.3287979746	0.274	0.119
GOM	-1	0.3333333333	-0.275	0.097
GOM	-2	0.3380617019	0.254	0.087
GOM	-3	0.3429971703	-0.268	-0.094
GOM	-4	0.3481553119	0.117	0.004
GOM	-5	0.3535533906	-0.012	-0.068
GOM	-6	0.3592106041	0.14	0.023
GOM	-7	0.3651483717	-0.015	0.032
GB	0	0.3287979746	0.252	0.213
GB	-1	0.3333333333	-0.082	0.056
GB	-2	0.3380617019	0.138	-0.158
GB	-3	0.3429971703	-0.025	-0.259
GB	-4	0.3481553119	-0.106	0.19
GB	-5	0.3535533906	-0.149	-0.026
GB	-6	0.3592106041	0.325	-0.055
GB	-7	0.3651483717	-0.05	0.006

MAB	0	0.3287979746	0.048	0.048
MAB	-1	0.3333333333	-0.234	-0.166
MAB	-2	0.3380617019	0.209	0.182
MAB	-3	0.3429971703	0.011	-0.261
MAB	-4	0.3481553119	-0.017	0.108
MAB	-5	0.3535533906	0.069	-0.033
MAB	-6	0.3592106041	0.102	0.023
MAB	-7	0.3651483717	-0.081	0.019

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