

Fat fish, thin fish: regime shifts in fish condition and environmental drivers

This supplemental material summarizes all of the Empirical Dynamic Modeling results from the paper.

Table S1. All Empirical Dynamic Modeling results including the p-value of the indicator causing fish condition, library size (L), embedding dimensions (E), and plot number corresponding to Supplementary Figure S1. Regions include the Northeast U.S. Shelf (NEUS), Gulf of Maine (GOM), Georges Bank (GB) and Mid-Atlantic Bight (MAB). Analyses with $E < 2$, inadequate time series overlap (TSO in the E column) or $\rho < 0$ include NAs for the other fields.

Fish condition	Condition region	Indicator	Indicator region	Rho	p-value	L	E	Plot #
Immature Mackerel	NEUS	Spring Sea Surface Temperature	NEUS	-0.06	NA	21	2	1A
Immature Mackerel	GOM	Spring Sea Surface Temperature	GOM	0.4	0.061	18	2	1B
Immature Mackerel	GB	Spring Sea Surface Temperature	GB	-0.42	NA	15	2	1C
Immature Mackerel	MAB	Spring Sea Surface Temperature	MAB	NA	NA	NA	1	
Immature Mackerel	GOM	Spring Bottom Temperature	GOM	0.42	0.042	19	2	1D
Immature Mackerel	GB	Spring Bottom Temperature	GB	-0.54	NA	20	2	1E
Immature Mackerel	MAB	Spring Bottom Temperature	MAB	NA	NA	NA	1	
Immature Mackerel	NEUS	Copepod Annual Size Index - Lagged	NEUS	0.48	0.023	24	2	1F
Immature Mackerel	NEUS	Copepod Annual Size Index- Lagged	GOM	0.72	0.002	24	2	1G
Immature Mackerel	NEUS	Copepod Annual Size Index- Lagged	GB	0.53	0.006	23	2	1H
Immature Mackerel	NEUS	Copepod Annual Size Index- Lagged	MAB	0.16	0.339	26	2	2A
Immature Mackerel	GOM	Copepod Annual Size Index- Lagged	GOM	0.3	0.162	18	2	2B
Immature Mackerel	GB	Copepod Annual Size Index- Lagged	GB	0.05	0.590	15	2	2C
Immature Mackerel	MAB	Copepod Annual Size Index- Lagged	MAB	NA	NA	NA	1	
Immature Mackerel	NEUS	Copepod Spring Size Index	NEUS	0.39	0.065	25	2	2D
Immature Mackerel	NEUS	Copepod Spring Size Index	GOM	0.29	0.183	24	2	2E
Immature Mackerel	NEUS	Copepod Spring Size Index	GB	0.16	0.359	22	2	2F
Immature Mackerel	NEUS	Copepod Spring Size Index	MAB	0.28	0.141	25	2	2G
Immature Mackerel	GOM	Copepod Spring Size Index	GOM	0.19	0.262	19	2	2H
Immature Mackerel	GB	Copepod Spring Size Index	GB	-0.41	NA	20	2	3A
Immature Mackerel	MAB	Copepod Spring Size Index	MAB	NA	NA	NA	1	
Immature Mackerel	NEUS	Euphausiid Annual Anomaly- Lagged	GOM	0.71	0.006	22	2	3B
Immature Mackerel	GOM	Euphausiid Annual Anomaly- Lagged	GOM	0.28	0.246	18	2	3C
Immature Mackerel	NEUS	Euphausiid Spring Anomaly	GOM	0.45	0.044	22	2	3D
Immature Mackerel	GOM	Euphausiid Spring Anomaly	GOM	0.09	0.647	19	2	3E
Immature Mackerel	NEUS	Larvacean Annual Anomaly- Lagged	GOM	0.49	0.008	23	2	3F
Immature Mackerel	NEUS	Larvacean Spring Anomaly	GOM	0.33	0.097	22	2	3G
Immature Mackerel	GOM	Larvacean Annual Anomaly- Lagged	GOM	0.31	0.139	18	2	3H

Fish condition	Condition region	Indicator	Indicator region	Rho	p-value	L	E	Plot #
Immature Mackerel	GOM	Larvacean Spring Anomaly	GOM	0.11	0.433	19	2	4A
Immature Mackerel	NEUS	Zooplankton Summer Anomaly - Lagged	MAB	NA	NA	NA	TSO < 19	
Immature Mackerel	MAB	Zooplankton Summer Anomaly - Lagged	MAB	NA	NA	NA	1	
Mature Mackerel	NEUS	Spring Sea Surface Temperature	NEUS	0.53	0.012	18	3	4B
Mature Mackerel	GOM	Spring Sea Surface Temperature	GOM	NA	NA	NA	1	
Mature Mackerel	GB	Spring Sea Surface Temperature	GB	NA	NA	NA	1	
Mature Mackerel	MAB	Spring Sea Surface Temperature	MAB	NA	NA	NA	1	
Mature Mackerel	GOM	Spring Bottom Temperature	GOM	NA	NA	NA	1	
Mature Mackerel	GB	Spring Bottom Temperature	GB	NA	NA	NA	NA	
Mature Mackerel	MAB	Spring Bottom Temperature	MAB	NA	NA	NA	1	
Mature Mackerel	NEUS	Copepod Annual Size Index - Lagged	NEUS	0.6	0.010	24	3	4C
Mature Mackerel	NEUS	Copepod Annual Size Index - Lagged	GOM	0.8	0.008	19	3	4D
Mature Mackerel	NEUS	Copepod Annual Size Index - Lagged	GB	0.67	0.008	19	3	4E
Mature Mackerel	NEUS	Copepod Annual Size Index- Lagged	MAB	0.38	0.080	26	2	4F
Mature Mackerel	NEUS	Copepod Spring Size Index	NEUS	0.59	0.006	22	3	4G
Mature Mackerel	NEUS	Copepod Spring Size Index	GOM	0.45	0.020	19	3	4H
Mature Mackerel	NEUS	Copepod Spring Size Index	GB	-0.12	NA	18	3	5A
Mature Mackerel	NEUS	Copepod Spring Size Index	MAB	-0.11	NA	22	3	5B
Mature Mackerel	NEUS	Euphausiid Annual Anomaly- Lagged	GOM	0.8	0.012	21	3	5C
Mature Mackerel	GOM	Euphausiid Annual Anomaly- Lagged	GOM	NA	NA	NA	1	
Mature Mackerel	NEUS	Euphausiid Spring Anomaly	GOM	0.46	0.022	19	3	5D
Mature Mackerel	GOM	Euphausiid Spring Anomaly	GOM	NA	NA	NA	1	
Mature Mackerel	NEUS	Larvacean Annual Anomaly- Lagged	GOM	0.69	0.006	21	3	5E
Mature Mackerel	GOM	Larvacean Annual Anomaly- Lagged	GOM	NA	NA	NA	1	
Mature Mackerel	NEUS	Larvacean Spring Anomaly	GOM	0.45	0.010	19	3	5F
Mature Mackerel	GOM	Larvacean Spring Anomaly	GOM	NA	NA	NA	1	
Mature Mackerel	NEUS	Zooplankton Summer Anomaly - Lagged	MAB	NA	NA	NA	TSO < 19	
Mature Mackerel	MAB	Zooplankton Summer Anomaly - Lagged	MAB	NA	NA	NA	TSO < 19	
Butterfish	NEUS	Spring Sea Surface Temperature	NEUS	0.23	0.139	15	4	5G
Butterfish	GOM	Spring Sea Surface Temperature	GOM	NA	NA	NA	TSO < 10	
Butterfish	GB	Spring Sea Surface Temperature	GB	0.24	0.221	22	2	5H
Butterfish	MAB	Spring Sea Surface Temperature	MAB	-0.18	NA	19	3	6A
Butterfish	NEUS	Spring Bottom Temperature	GOM	-0.09	NA	15	4	6B
Butterfish	GOM	Spring Bottom Temperature	GOM	NA	NA	NA	TSO < 10	
Butterfish	GB	Spring Bottom Temperature	GB	0.3	0.147	22	2	6C
Butterfish	MAB	Spring Bottom Temperature	MAB	0.34	0.049	21	3	6D
Butterfish	GOM	Summer Bottom Temperature	GOM	NA	NA	NA	TSO < 10	
Butterfish	GB	Summer Bottom Temperature	GB	-0.05	NA	24	2	6E
Butterfish	MAB	Summer Bottom Temperature	MAB	-0.02	NA	19	3	6F
Butterfish	NEUS	Fall Bottom Temperature	GOM	0.12	0.321	16	4	6G

Fish condition	Condition region	Indicator	Indicator region	Rho	p-value	L	E	Plot #
Butterfish	NEUS	Fall Bottom Temperature	GB	0.14	0.341	16	4	6H
Butterfish	NEUS	Fall Bottom Temperature	MAB	0.3	0.544	16	4	7A
Butterfish	NEUS	Copepod Annual Size Index	NEUS	-0.23	NA	15	5	7B
Butterfish	NEUS	Copepod Annual Size Index	GOM	-0.2	NA	15	5	7C
Butterfish	NEUS	Copepod Annual Size Index	GB	-0.33	NA	15	4	7D
Butterfish	NEUS	Copepod Annual Size Index	MAB	0.05	0.459	15	4	7E
Butterfish	GOM	Copepod Annual Size Index	GOM	NA	NA	NA	TSO < 10	
Butterfish	GB	Copepod Annual Size Index	GB	0.42	0.058	22	2	7F
Butterfish	MAB	Copepod Annual Size Index	MAB	0.04	0.679	22	3	7G
Butterfish	NEUS	Copepod Spring Size Index	NEUS	-0.08	NA	15	5	7H
Butterfish	NEUS	Copepod Spring Size Index	GOM	-0.04	NA	17	4	8A
Butterfish	NEUS	Copepod Spring Size Index	GB	-0.54	NA	15	4	8B
Butterfish	NEUS	Copepod Spring Size Index	MAB	-0.3	NA	15	4	8C
Butterfish	GOM	Copepod Spring Size Index	GOM	NA	NA	NA	TSO < 10	
Butterfish	GB	Copepod Spring Size Index	GB	0.29	0.161	24	2	8D
Butterfish	MAB	Copepod Spring Size Index	MAB	0.015	0.633	22	3	8E
Butterfish	NEUS	Copepod Fall Size Index	NEUS	-0.47	NA	17	4	8F
Butterfish	NEUS	Copepod Fall Size Index	GOM	-0.48	NA	17	4	8G
Butterfish	NEUS	Copepod Fall Size Index	GB	-0.26	NA	15	4	8H
Butterfish	NEUS	Copepod Fall Size Index	MAB	-0.19	NA	15	4	9A
Butterfish	GOM	Copepod Fall Size Index	GOM	NA	NA	NA	TSO < 10	
Butterfish	GB	Copepod Fall Size Index	GB	0.46	0.017	22	2	9B
Butterfish	MAB	Copepod Fall Size Index	MAB	-0.07	NA	18	3	9C
Butterfish	NEUS	Larvacean Spring Anomaly	GOM	0.12	0.421	15	4	9D
Butterfish	GOM	Larvacean Spring Anomaly	GOM	NA	NA	NA	TSO < 10	
Butterfish	NEUS	Euphausiid Spring Anomaly	GOM	-0.04	NA	15	4	9E
Butterfish	GOM	Euphausiid Spring Anomaly	GOM	NA	NA	NA	TSO < 10	
Butterfish	NEUS	Zooplankton Summer Anomaly	MAB	NA	NA	NA	TSO < 10	
Butterfish	MAB	Zooplankton Summer Anomaly	MAB	NA	NA	NA	TSO < 10	

Figure S1. Convergent cross mapping (CCM) for all combinations of species, maturities and environmental indices with adequate overlapping time series and embedding dimensions >1. See Table S1 for inclusion criteria and corresponding modeling results.

