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Sea Temperature Effects on Species Abundance

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ABSTRACT

Relative abundance fluctuations of the eight highest unit value species of the northern Gulf of Maine are associated with sea temperature cycles.

A previous report (1) demonstrated the effect of climatic cycles on fluctuations in the relative abundance of the American lobster (H. americanus) as measured by catch and fishing effort over a major portion of its range — Newfoundland to New York — and by inference over the remainder of its range — New Jersey to North Carolina.

Other and more recent studies indicate that catches of the eastern oyster (C. virginica), hard clam (M. mercenaria), bloodworm (G. dibranchiata), sandworm (N. virens), sea scallop (P. magellanicus), soft clam (M. arenaria), and northern shrimp (P. borealis) have also fluctuated during the same temperature cycle within the more discrete area of the northern Gulf of Maine (2).

These eight species, because of their individual unit value, are intensively exploited, with an estimated 55 to 90 percent of the commercial supply, depending upon regulation and species, being caught each year (3). Population inventories in Maine indicate that catch data are reliable indicies of relative abundance.

The 1939-1967 sea temperature cycle, which coincided with improved catch data collection, commenced with the second lowest annual mean at Boothbay Harbor, Maine, since the National Marine Fisheries Service or its predecessor agencies first recorded daily observations in 1905; increased rapidly to the 1953 record high and declined precipitately to the 1967 terminal low (4).

Sea temperature fluctuations and associated meteorological conditions influence predation, reproductive success, winter survival, ice cover,

sediment compaction, erosion and redistribution, feeding time, dissolved oxygen, salinity, disease, length of growth period to legal or market size, total natural mortality, and for some species temperature-precipitation associated declines in the abundance and availability of food (5).

Shrimp, hard clams, and oysters are near or at the extremity of their range (6) and exhibit abundance instability as well as susceptibility to commercial extinction during years of unfavorable temperatures (7); the more centrally located species: lobster, the annelids, sea scallop and soft clam have been relatively stable in their abundance. Each species has responded directly or inversely to temperature fluctuations, depending upon its optimum position within the temperature range (8).

Coefficients of sea temperature-relative abundance correlation with their degrees of significance (Table 1) appear to be consistent with solar-climatic correlations reported by Willett and Prohaska (9).

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Table 1

ASSOCIATION OF SEA TEMPERATURE AND RELATIVE ABUNDANCE* OF SELECTED SPECIES

Year	Sea Surface Temperature (°C.) (Annual Mean)	Oyster *C. virginica*	Hard Clam *M. mercenaria*	Lobster *H. americanus*	Bloodworms *G. dibranchiata*	Sandworms *N. (Nereis) virens*	Scallop *P. magellanicus*	Soft Clam *M. arenaria*	Shrimp *P. borealis* (log of metric tons)
1939	6.4		0	3,005					2.12
1940	7.0		2	3,467				2,641	2.25
1941	7.8		54	4,054			230	4,450	2.40
1942	8.1		56	3,812			206	3,583	1.86
1943	7.4		36	5,202			231	4,068	1.95
1944	8.0		14	6,376			232	3,911	1.08
1945	8.4		137	8,677			171	3,119	.70
1946	8.5		76	8,517			142	2,323	.48
1947	9.2		44	8,290			110	2,505	1.30
1948	8.2		131	7,223			65	1,881	1.67
1949	10.1		268	8,742	95	71	99	1,688	1.23
1950	9.6		228	8,324	115	111	148	1,189	--
1951	10.8	2.6	258	9,415	109	129	111	1,141	--
1952	10.1	1.4	192	9,087	92	81	49	891	--
1953	11.1	2.0	152	10,112	77	128	49	741	--
1954	10.2	2.6	132	9,818	108	132	33	658	.30
1955	10.0	1.5	113	10,302	140	122	63	941	.70
1956	9.2	1.6	131	9,316	194	244	70	837	1.61
1957	9.4	1.2	164	11,068	249	278	79	899	1.46
1958	8.5	1.3	115	9,665	270	292	106	831	2.19
1959	8.3	.4	73	10,126	264	307	135	816	2.38
1960	8.9	.8	29	10,889	249	369	123	891	2.61
1961	8.5	.7	6	9,485	258	350	92	1,365	2.97
1962	8.1	.4	1	10,013	241	325	273	1,441	3.22
1963	8.8	1.9	1	10,344	205	361	164	1,528	3.48
1964	8.3	1.8	1	9,713	223	320	162	1,876	3.75
1965	7.7	.2	1	8,556	189	316	231	2,385	4.05
1966	7.6	0	0	9,034	177	305		2,381	3.91
1967	7.3	0	0	7,479	159	304			3.90
Coefficient of Correlation r =		0.82	0.79	0.63	-0.67	-0.81	-0.74	-0.68	-0.66
$F_{.99}$ =		.606	.470	.470	.575	.575	.505	.487	.470

*Abundance is expressed in metric tons