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A METHOD OF PREDICTING FLUCTUATIONS IN THE SEA SCALLOP POPULATIONS OF MAINE

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DISTRIBUTION OF THE RESOURCE

The sea scallop (Placopecten magellanicus) resource of the State of Maine consists of relatively distinct populations occupying the bottom of estuaries and embayments from the Piscataqua River, separating Maine and New Hampshire, eastward to the St. Croix River which forms the international boundary with the Province of New Brunswick. Vertical distribution ranges from mean low water in some areas to depths of several hundred feet in others.

Concentrations of commercial importance are limited to the area from Penobscot Bay eastward. The most extensive populations are those of Penobscot Bay to Mt. Desert Island. In recent years landings from that area have ranged from 40 to 90 percent of the total inshore catch. Sporadic and generally non-commercial dragging has been carried on in Casco Bay, Sheepscot Bay, and the lower Damariscotta River.

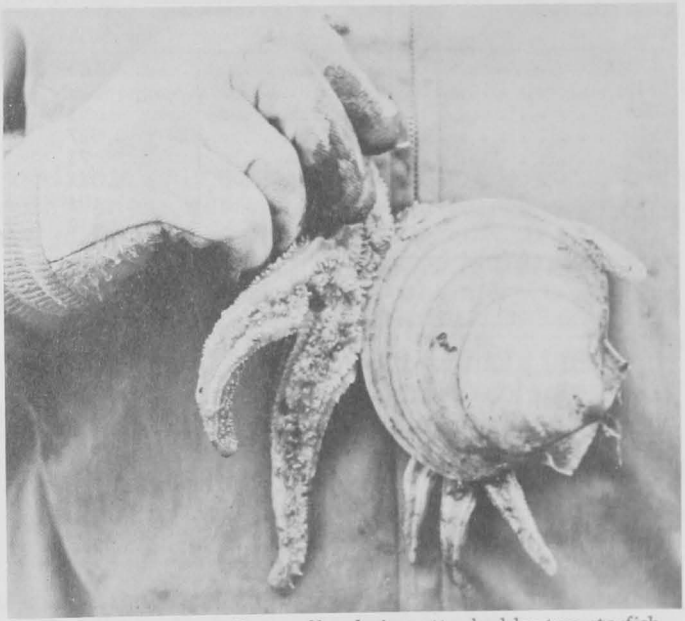

Fig. 1 - A Penobscot Bay scallop being attacked by two starfish.

THE FISHERY

The fishery appears to have had its beginning about 1880 but records of landings are extant only since 1887 and then with several gaps, principally in the 1890's and between the end of World War I and the 1930's. Consecutive annual landings data are limited to the period since 1938.

The open season from November 1 through the following March 31 has been inspired by two considerations: (1) the low-water temperatures of the winter make the scallops less active and, therefore, less able to escape the small inefficient drags used in the fishery, and (2) it provides off-season employment for those fishermen who normally are engaged in other fishing activities during the remainder of the year. Since the catch is reported by calendar year, each year's landings include portions of two fishing seasons.

Sampling of the catch from 1949 to 1953 and in 1957-58 indicated that toward the end of each fishing season (January-March) an increasing number of scallops that have completed their sixth growing season enter the fishery. By that time the population of older and larger scallops has been so reduced by fishing that fishermen depend upon the new crop for a con-

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tinuing source of supply. This year-class is fished twice during the calendar year. The January-March catch represents some 12 to 15 percent of the landings for the year. Following the seventh growing season the same year-class adds another 13 to 25 percent to the year's catch; the total contribution varying with the relative importance of the year-class to the available population. Landed value for the shucked meats which has ranged from 6 cents in 1887 to 61 cents in 1952, with a median of 25 cents per pound, has continuously attracted intensive commercial activity.

LANDINGS AND ABUNDANCE

The consistency with which periodic highs have alternated with lows in landings at approximately decade intervals suggests, with what is known of the fishery, that scallop abundance has likewise fluctuated in the inshore growing areas of Maine.

Table 1 - Maine Scallop Landings[1/], Selected Years 1889-1960

Year	Weight of Meats
	1,000 Lbs.
1889	295
1899	53
1910	2,027
1919	73
1933	1,073
1944	101
1950	512
1960	72

1/Shown are only landings from Maine "inshore waters." Not included are Maine landings from offshore waters or Georges Bank in those years when Maine vessels did fish those waters.

This assumption has been supported by the biological sampling of M. A. Chrysler (1920) in 1917, and of the Department of Sea and Shore Fisheries from 1949 to 1953 and in 1957-58 which forecasted the general trends landings were to take during immediately subsequent years.

SEA WATER TEMPERATURE

The only data which indicate why these fluctuations have taken place are records of sea water temperature taken at Boothbay Harbor by the U. S. Fish and Wildlife Service or its predecessor agencies since March 1905.

Since the offspring of any year's spawning--August to October--becomes of major importance to the fishery six years later, it appears from a study of temperature and production records that an association exists between sea water temperature six years earlier and highs and lows of scallop landings.

The values in table 2 suggest an optimum temperature of 46.0° F. to 46.5° F. for peak landings. Less favorable high and low temperatures yield the lowest landings.

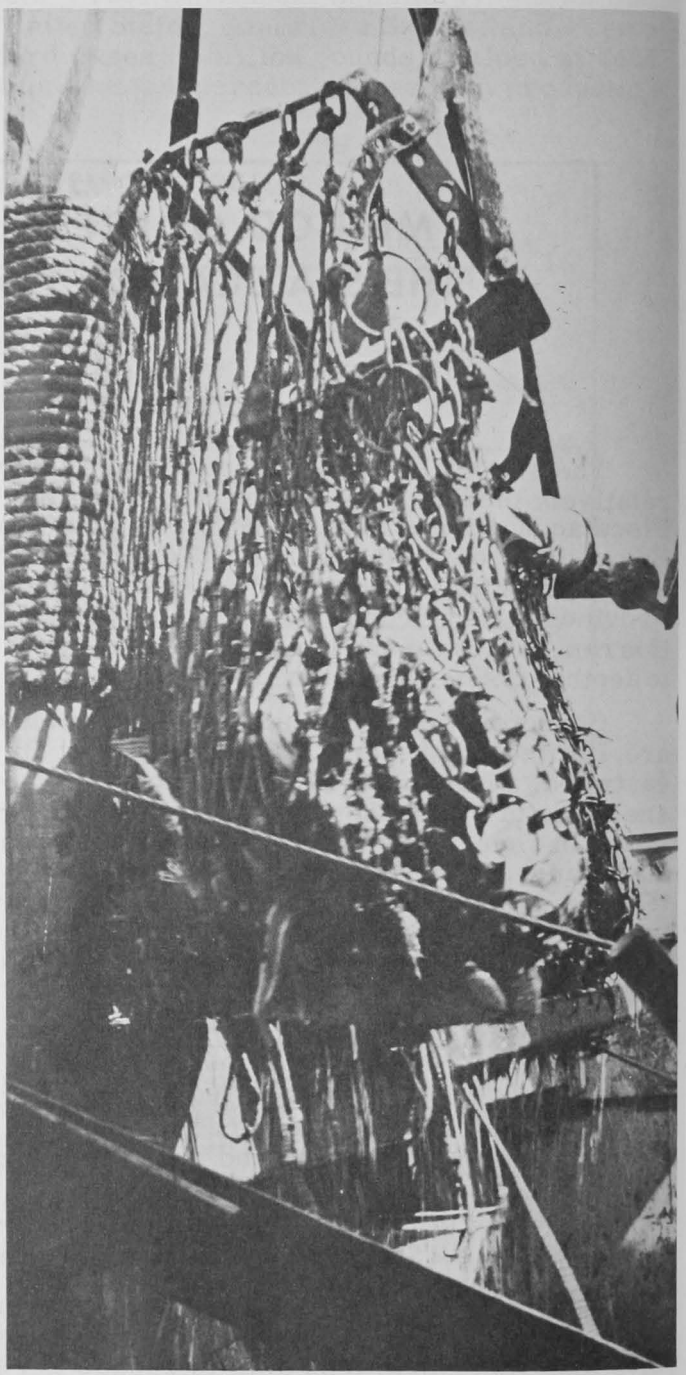

Fig. 2 - A typical Penobscot Bay scallop drag.

Table 2 - Relationship Between Sea Water Temperatures Six Years Earlier and Highs and Lows in Maine's Scallop Landings

Sea Water Temperature		Scallop Landings (Meats Only)	
Year	°F.	Year	1,000 Lbs.
1913	47.4	1919	73
1927	46.2	1933	1,073
1938	45.1	1944	101
1944	46.5	1950	512
1954	50.2	1960	72

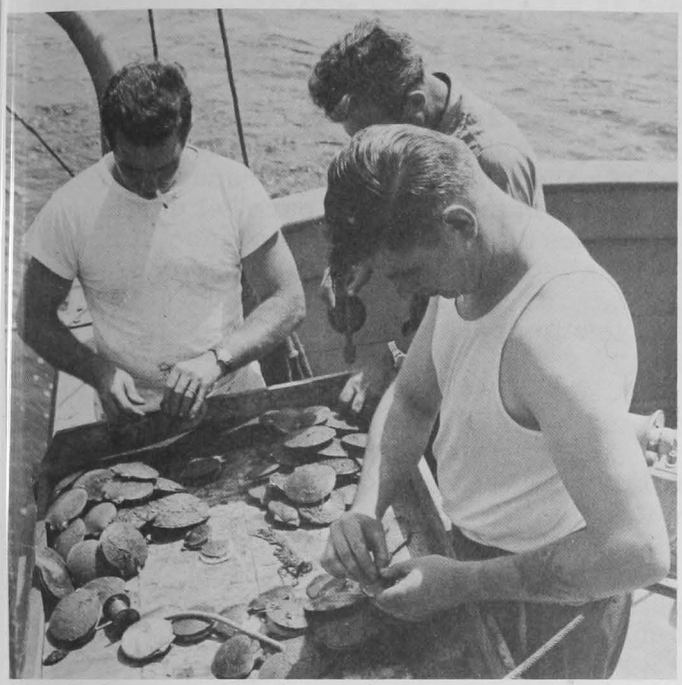

Fig. 3 - Tagging scallops for growth, mortality, and migration studies.

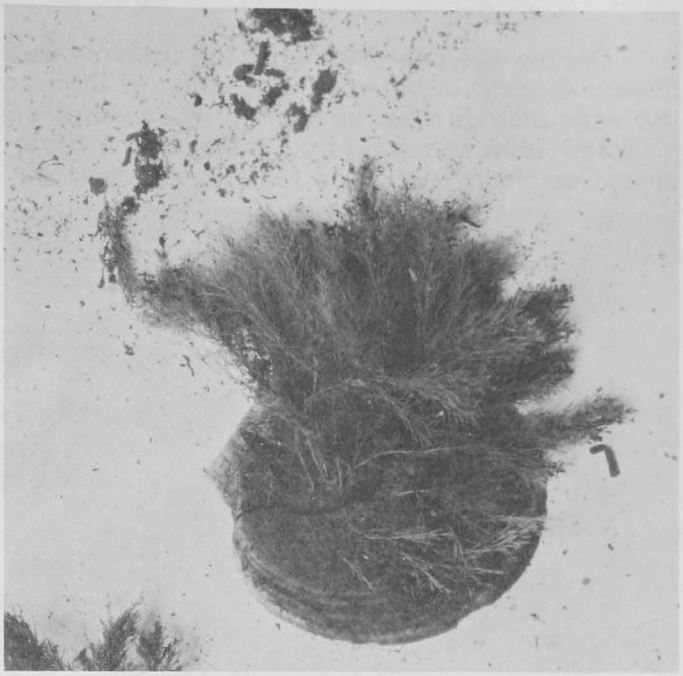

Fig. 4 - Bryozoon attached to adult scallop shell. Juvenile scallops in turn attached to Bryozoon.

Scallop landings for consecutive years are available only since 1938. The 24 years since 1938 were grouped by the amount of landings. Monthly mean sea water temperatures six years before were averaged for the corresponding years of landings. It was observed that years of low landings were preceded by extremely high or extremely low mean sea water temperatures. Therefore low landings were grouped according to the mean temperature six years previously.

Table 3 - Mean of Monthly Sea Water Temperatures (°F.) at Boothbay Harbor and Mean Annual Scallop Landings Six Years Later

Months												Annual Mean	Mean Scallop Landings (Meats) 6 Yrs. Later	Number of Years
Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.			
(°F.)													1,000 Lbs.	
33	31	33	37	46	53	59	60	56	49	42	37	45	120	4
35	34	35	40	48	55	60	61	57	50	45	38	46	500	8
37	35	37	42	48	56	62	63	59	53	48	43	49	250	8
41	40	41	45	51	57	62	62	60	55	50	45	51	105	4

The data summarized in table 3 suggest that seasonal temperatures are more closely related to subsequent yield than are annual means. October-November temperatures appear to be representative of the critical August-December spawning and post-spawning period. March-April temperatures representative of the winter-spring period appear to be equally important to the association between temperature and relative scallop abundance. This association is shown in table 4.

Table 4 - Seasonal Associations Between Temperature and Landings in Maine

Temperature Years	Mean of March-April and October-November Sea Water Temperature in °F. at Boothbay Harbor	Sea Scallop Landings (Meats Only)		
		Six Years Later	Range of Landings	Scallop Landings Years
		1,000 Lbs.		
1938, 1939	39.9	103	101-105	1944, 1945
1936, 1940, 1948	41.4	137	131-144	1942, 1946, 1954
1934, 1942	41.6	455	454-456	1940, 1948
1941, 1943, 1944	42.6	509	507-512	1947, 1949, 1950
1932	43.3	793	-	1938
1933, 1945	43.4	387	378-395	1939, 1951
1935, 1946, 1950	44.4	319	314-327	1941, 1952, 1956
1937, 1951	45.8	236	219-243	1943, 1957
1947, 1949	46.2	231		1953, 1955
1952, 1953, 1955	47.4	123	108-138	1958, 1959, 1961
1954	48.0	72	-	1960

SUMMARY

During the past 80 years the inshore sea scallop fishery in Maine has alternated at about decade intervals between extremes of high and low landings. The financial attractiveness of the resource during the winter when other species are less available, the comparatively restricted area occupied by scallops, and biological sampling of the population support the assumption that yield is an acceptably reliable index of relative abundance. Trends of sea water temperature closely parallel declines and increases in the relative abundance of sea scallops as indicated by landings and suggest an optimum range as well as unfavorable high and low temperatures.

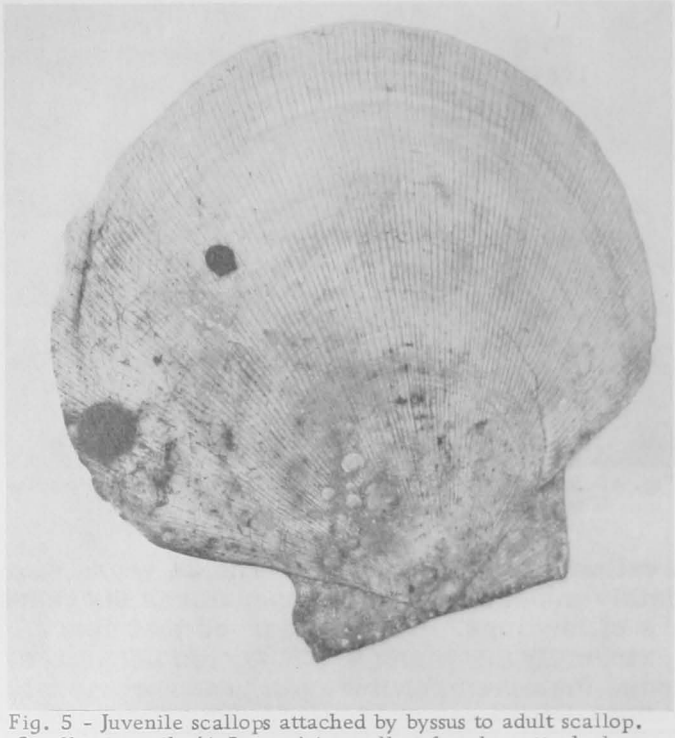

Fig. 5 - Juvenile scallops attached by byssus to adult scallop. Smaller juvenile (4.5 mm.) is smallest found so attached. Juveniles slightly smaller than this were found attached only to Bryozoa or hydroids. Larger juvenile (9.6 mm.) is approximately largest found attached to scallop shell.

CONCLUSIONS

1. Sea water temperature is directly related to sea scallop abundance in Maine waters.

2. Optimum spring-fall sea water temperature (March-April and October-November) ranges from approximately 41.5° F. to 43.5° F.

Table 5 - Predicted Probable Annual Yield of the Maine Inshore Sea Scallop Fishery, 1962-1967

March-April and October-November Temperature		Predicted Scallop Landings (Meats Only)	
Year	Temp. °F.	Year	Quantity 1,000 Lbs.
1956	45.6	1962	240
1957	45.3	1963	270
1958	44.2	1964	350
1959	43.7	1965	370
1960	43.9	1966	350
1961	43.8	1967	360

3. If the long-range sea water temperature trend recorded since 1905 continues, it may be anticipated that average annual long-term sea scallop landings from Maine waters will continue to decline. It may be further anticipated that annual scallop landings will average approximately 100,000 pounds by 1980.

4. On the basis of 1956-1961 sea water temperature at Boothbay Harbor, predictions with respect to the probable yield of the Maine inshore sea scallop fishery are shown for the period 1962-1967 in table 5.

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