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SCALLOP RESOURCE OF THE UNITED STATES PASSAMAQUODDY AREA

SPECIAL SCIENTIFIC REPORT–FISHERIES No. 367

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

United States Department of the Interior, Fred A. Seaton, Secretary
Fish and Wildlife Service, Arnie J. Suomela, Commissioner
Bureau of Commercial Fisheries, Donald L. McKernan, Director

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United States Fish and Wildlife Service
Special Scientific Report--Fisheries No. 367

Washington, D. C.
December 1960

This is International Passamaquoddy Fisheries Board, 1956-59, Scientific Report No. 22.

This work was financed by the Bureau of Commercial Fisheries under Contract No. 14-19-008-9374, with funds provided for the Passamaquoddy Tidal Survey (Public Law 401, 84th Congress, 2d Session).

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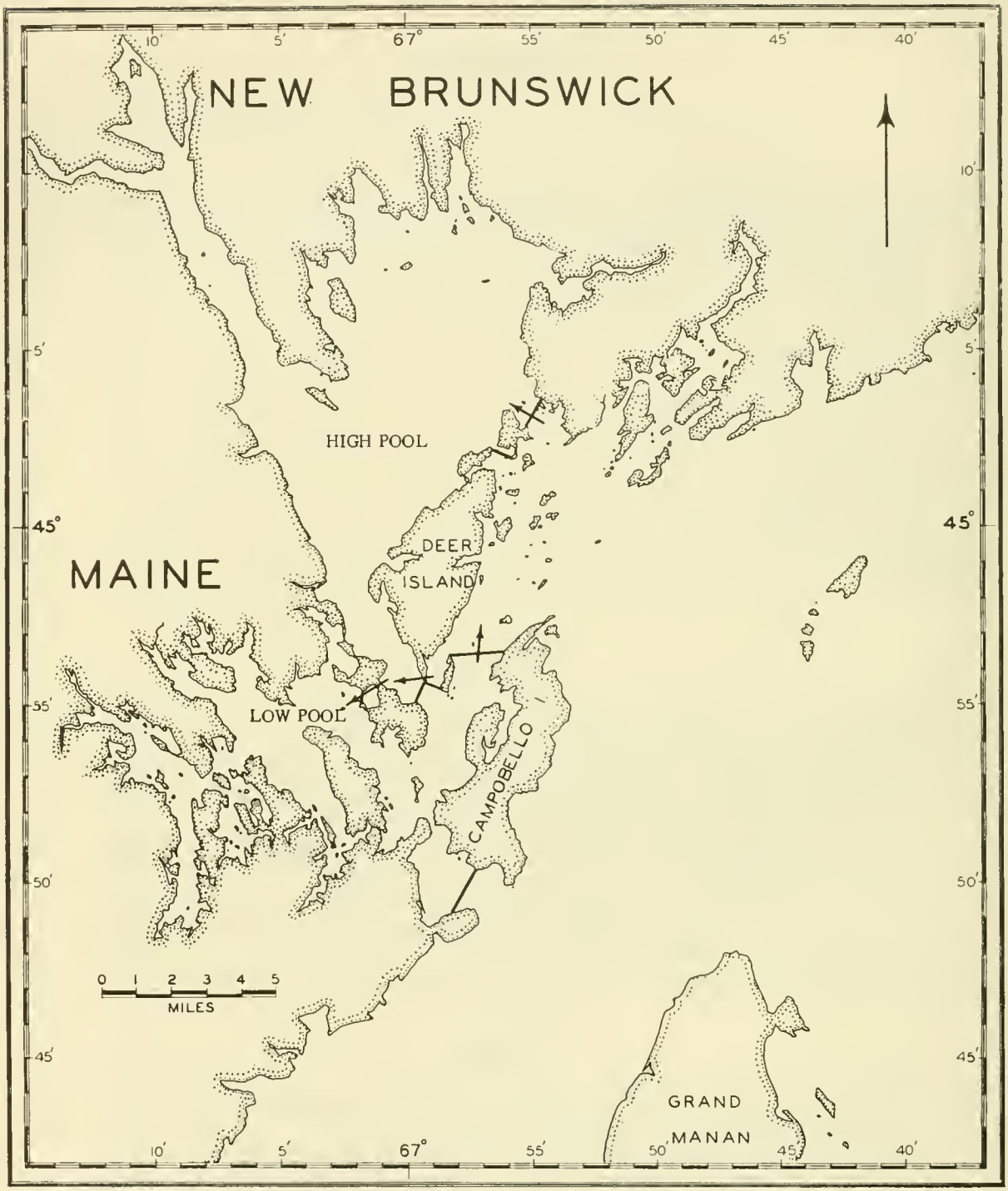

Figure 1.--Chart of the Quoddy Region showing location of proposed dams.

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ABSTRACT

A survey of the scallop fishery in the Passamaquoddy Bay area of Maine was made as part of a larger investigation into the past, present, and future status of fish and shellfish species that might be affected by the construction of a proposed tidal power plant in that region. The past record of commercial production, and the present abundance level and environmental conditions are described, together with deductions as to the effects on the scallop fishery of predicted oceanographic changes.

INTRODUCTION

In 1956, Canada and the United States requested the International Joint Commission to ascertain the feasibility, desirability, and cost of constructing a hydroelectric power plant in Passamaquoddy and Cobscook Bays. Turbines would be turned by the flow of sea water through two natural basins impounded by dams.

The responsibility for studying the probable effects of construction, maintenance, and operation of the proposed structure on the fisheries of the area was given to the International Passamaquoddy Fisheries Board. Accordingly, Canadian and United States scientists studied the oceanographic, biologic, and economic characteristics of the "Quoddy Region" (fig. 1). Geographically this northeastern segment of the Atlantic coast includes the Passamaquoddy area of southern New Brunswick and eastern Maine. It is divided into the St. Croix River estuary or "high pool", which forms the international boundary with Canada, and adjacent Cobscook Bay or "low pool", enclosed by land projections.

A contract between the United States Bureau of Commercial Fisheries and the Maine Department of Sea and Shore Fisheries assigned to the State agency the task of investigating species of fish and shellfish, exclusive of herring, in the Quoddy Region.

The sea scallop *(Placopecten magellanicus)* supports the second largest mollusk fishery of the Passamaquoddy area, and the third most important fishery in terms of landed value. Only the sea herring and soft-shell clam fisheries are more valuable. The Quoddy Region is almost completely dependent, economically, upon marine resources. Over the period 1948-57, the Quoddy Region accounted for 43.3 percent of Washington County's scallop catch and approximately 4 percent of the total Maine landings (table 1).

Table 1. Annual sea scallop landings in the Quoddy Region, Washington County, and State of Maine, 1948-57; catch refers to scallop meats

Year	Quoddy Region			Washington County			Maine	
	Catch in pounds	Value in dollars	Percent of county catch	Catch in pounds	Value in dollars	Percent of state catch	Catch in pounds	Value in dollars
1948	19,813	8,340	41.0	48,325	20,342	10.7	453,686	217,662
1949	20,066	6,634	41.0	48,941	16,180	9.6	508,916	179,845
1950	40,408	15,741	41.0	98,557	38,392	18.8	524,824	215,725
1951	33,313	14,139	41.0	81,250	34,463	12.0	676,803	310,530
1952	40,499	22,274	45.0	89,980	49,512	6.0	1,495,754	852,460
1953	16,937	9,096	35.0	48,391	25,971	2.9	1,697,172	786,673
1954	17,459	7,577	45.0	38,798	16,823	5.5	707,758	334,241
1955	54,939	29,282	40.7	134,922	71,886	12.1	1,113,564	580,541
1956	46,431	23,726	40.0	116,078	59,320	12.0	969,918	518,437
1957	35,653	17,673	77.5	45,987	22,524	6.2	745,251	369,439
Average	32,552	15,448	43.3	75,123	35,541	8.4	889,365	436,555

LIFE HISTORY

Range and Distribution

The range of the sea scallop is from New Jersey to Labrador. It is especially abundant along the Maine coast and on Georges Bank in depths of 10 to 100 fathoms.

Spawning

In Maine waters, the adult scallop spawns between late August and early October, with the peak occurring in September. As with many other bivalve species, fertilization takes place in the water.

Larval and Juvenile Development

Baird (1953) has described the young, approximately 1 mm. and larger, that were found in many inshore areas of Maine. These scallops were fixed to bryozoans which, in turn, were attached to the shells of scallops, both alive and dead, or to shells of other mollusks. Attachment of the scallops appears to last from postpelagic settlement to well into the second growing season. Young scallops 4 to 9 mm. long have been frequently observed attached by the byssus to shells (fig. 2). Scallops larger than 9 mm. are seldom fastened by their byssal threads.

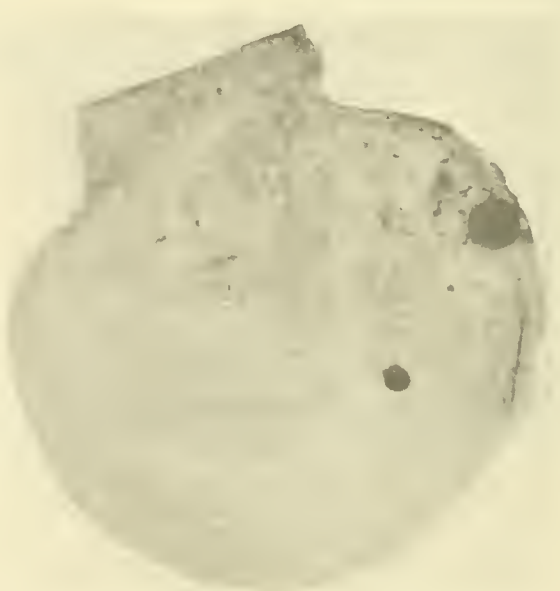

Figure 2.--Approximately the smallest (4.5 mm.) and the largest (9.6 mm.) juvenile scallops found attached by byssus to adult scallops (Baird, 1953).

Growth

During the second growing season, the young scallop in the 5- to 12-mm. class apparently leaves its original host and attaches itself to shells or bottom debris by its byssus. Shell growth is most rapid during the following growing season, after which it is much slower. The relation of meat yield to shell diameter changes with the age of the animal, meat growth continuing at a relatively high rate after the third growing season (Baird, 1956).

Table 2.--Average age-length of Maine sea scallops

[Baird, 1953 and 1954b]

Growing seasons	Age	Size
No.	Years	Mm.
1	0.5	2
2	1.5	5-12
3	2.5	56
4	3.5	74
5	4.5	89
6	5.5	104
7	6.5	112
8	7.5	119
9	8.5	124
10	9.5	130

Growing Areas

Scallop-growing areas in Cobscook Bay and the St. Croix estuary are shown in figure 3. Characteristics of these areas with respect to depth of water and type of bottom are as follows:

1. Whiting Bay - average depth at mean low water, 34 feet; range, 28 to 41 feet; bottom varying from hard to soft.
2. Dennys Bay - depth at mean low water, 40 feet; range, 26 to 72 feet; average bottom, hard.
3. Pennamaquan River - average depth at mean low water, 33 feet; range, 23 to 42 feet; average bottom, soft.
4. Southeast of Hersey Neck (East Bay) - mean depth at mean low water, 43 feet; range, 25 to 67 feet; average bottom, soft.
5. Northeast of Denbow Neck - average depth at mean low water, 45 feet; range, 26 to 103 feet; bottom varying from hard to soft.
6. Northwest of Seward Neck - average depth at mean low water, 51 feet; range, 21 to 72 feet; bottom, hard.
7. Seward Neck - Denbow Neck - average depth at mean low water, 36 feet; range, 7 to 61 feet; bottom varying from hard to soft.
8. Southwest of Shackford Head (Eastport) - average depth at mean low water, 98 feet (dragged only during slack-water periods); range, 72 to 138 feet; bottom ranging from soft to hard.
9. Northwest of Lubec (Johnson Bay) - average depth at mean low water, 44 feet; range, 27 to 54 feet; average bottom, soft.
10. St. Croix River estuary - average depth at mean low water, 197 feet; range, 139 to 240 feet; average bottom, soft.

THE SCALLOP FISHERY

History of Commercial Activity

A small number of resident fishermen drag for scallops in Cobscook Bay and the St. Croix River estuary each year during the open season from November 1 through March 31. Wide fluctuations in abundance have been reported by commercial fishermen. When scallops are relatively abundant, increased landings are made by larger

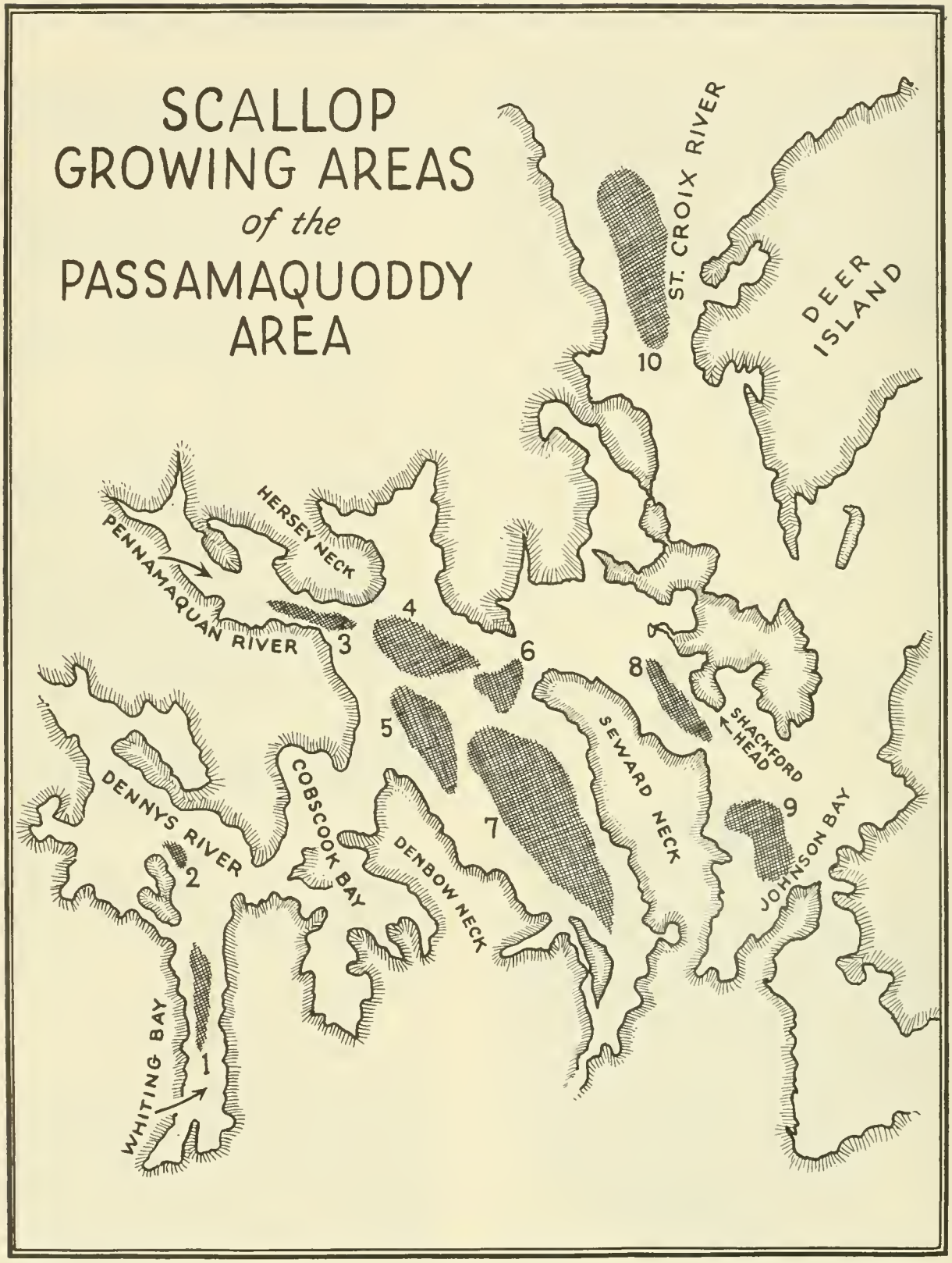

Figure 3.--Chart showing distribution of scallop-growing areas in the Quoddy Region.

boats from Maine ports outside the area. As catches decrease, the outside boats leave the area and the fishery is carried on by small, locally owned and operated boats. The number of local, licensed scallop boats during the past decade has averaged 4. Landings from both pools during recent years are characteristic of the abundance fluctuations (table 3).

Table 3.--Landings of sea scallops and number of local licensed sea-scallop boats in Quoddy Region, 1948-57

Year	Catch (scallop meats)						Licensed scallop boats
	High pool		Low pool		Total		
	Catch	Value	Catch	Value	Catch	Value	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars	Number
1948	--	--	19,813	8,340	19,813	8,340	3
1949	--	--	20,066	6,634	20,066	6,634	5
1950	--	--	40,408	15,741	40,408	15,741	10
1951	4,063	1,732	29,250	12,407	33,313	14,139	3
1952	4,499	2,474	36,000	19,800	40,499	22,274	--
1953	2,420	1,300	14,517	7,796	16,937	9,096	1
1954	1,940	842	15,519	6,735	17,459	7,577	2
1955	970	517	53,969	28,765	54,939	29,282	5
1956	--	--	46,431	23,726	46,431	23,726	9
1957	--	--	35,653	17,673	35,653	17,673	5
Average	1,389	686	31,163	14,762	32,552	15,448	4

Composition of Catch

During the 1957-58 season 212 scallops obtained from 2 days of dragging in Passamaquoddy Bay were studied for age and growth (tables 4 and 5). The resulting information provided an estimate of age and growth of scallops in the area. This sampling of the commercial catch indicates that the fishery has been supported by rather good survival of some four or five year classes. Greatly decreased landings in 1958 indicate that the available supply has been fairly well fished out, and landings will continue to be low until a new stock enters the fishery.

Tagging studies (fig. 4) on possible migratory activity have shown that there is no appreciable migration of adult scallops in Penobscot Bay, Maine's largest and most intensively fished scallop area (Baird, 1954a). The size distribution in table 4 is

Table 4.--Comparative size distributions of sea scallops in commercial catches from Passamaquoddy and Penobscot Bays

Size	Penobscot Bay	Passamaquoddy Bay
Cm.	Percent	Percent
5	0.2	--
6	1.4	--
7	4.4	--
8	5.6	--
9	6.5	--
10	14.4	1.4
11	13.9	25.0
12	19.5	45.8
13	18.3	22.6
14	9.0	5.2
15	5.1	--
16	1.2	--
17	0.5	--
Total	100.0	100.0

Table 5.--Age and size distribution of sea scallops in commercial catches from Passamaquoddy Bay, 1957-58 season

Age	Average size	Range	Composition
Years	Cm.	Cm.	Percent
6	11.2	10.6 - 11.6	14.3
7	12.2	11.8 - 12.6	32.1
8	12.8	12.3 - 13.4	35.7
9	13.2	13.0 - 13.5	17.9

based on extensive work with commercial catches. Baird believes that good survival of certain year classes with intervening years of poor year class survival combined with drag selectivity "could well account for" the sudden appearance or disappearance of scallop concentrations in areas of commercial operations.

Comparison with Other Areas

The scallop fishery of the Passamaquoddy area appears to be marginal and at present could not support any increase in fishing effort. Aging of samples from the commercial catch indicates more frequent year-class failure in the Passamaquoddy areas than in other commercially important inshore areas. Figure 5 shows the difference between size-class distributions in the commercial catches from Passamaquoddy Bay and Penobscot Bay. The same type of drag was used to collect both samples, although the two samplings were not done during the same year. Growth rates for the two areas appear to be approximately the same.

Figure 4.--Scallops tagged with plastic disks, a portion of nearly 2,000 similarly marked between December 1949 and June 1951 in a migration study.

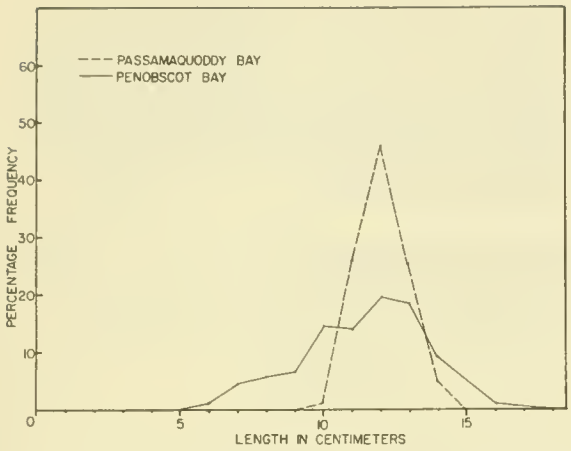

Figure 5.--Size distribution of scallops in the commercial fishery.

EXPECTED CHANGES

The major changes in the environment anticipated from the construction of dams will be inside Passamaquoddy and Cobscook Bays and immediately outside the dams. They include changes in the rate of water exchange and therefore will be of great significance to the native scallops. These relatively sedentary animals must adapt to their environment or perish. Changes in scallop distributions must be forecast with a knowledge of probable oceanographic changes.

Oceanographic Effects

Forty-three oceanographic cruises, under the auspices of the International Passamaquoddy Fisheries Board, covered a network of stations in the Quoddy Region during 1957 and 1958 and yielded pertinent information concerning general patterns of water levels, currents, temperatures, salinities, etc. The following statements are based upon this information. The mean water level in the high pool will be raised about 6 feet; that of the low pool will be lowered about 5 feet. The mean tidal range, now approximately 20 feet, will be reduced in both high and low pools, to 4 feet and 8 feet, respectively.

Since the emptying and filling gates will be closed during most of each tidal cycle, current patterns in both pools will be greatly changed. When the gates are open, velocities in most areas should be only slightly lower than at present, but the rate of filling will, of course, be much slower. The flushing time, i.e., the average length of time required to remove 1-day's contribution of river water, is now from 8 to 20 days, varying with the amount of river discharge. Flushing time in the high pool will be doubled by dam construction. In the low pool, flushing time will be reduced somewhat.

Because of the 50-percent reduction in water exchange in the high pool, the accompanying decrease in vertical mixing will result in greater seasonal water-temperature variations, particularly at the surface. The maximum surface temperature in summer may increase from 54° to 68° F. Summer water temperatures throughout the low pool should increase to comparable levels. Partial ice cover may be expected in the winter.

Mean surface salinities will be 20 to 30 parts per thousand in the pools as compared with the present 30 to 33 parts per thousand, but bottom salinities are likely to change little.

Effects of Changes on Sea Scallops

The abundance of the sea scallop has fluctuated widely and will continue to fluctuate with or without impoundment. This species would be profoundly affected, however, by construction of the proposed dams.

It is expected that impoundment will increase scallop landings in the Quoddy Region. It was concluded by Dickie (1955) that fluctuations in the marketable scallop supply can be largely explained by fluctuations in water temperature. Low temperatures prolong the pelagic stages when the scallop is most vulnerable to plankton feeders and to wide dispersal by water currents. High temperatures, conversely, are favorable to larval survival, as are low rates of water exchange. Studies have indicated that the number of larvae which settle on their parent beds is

inversely proportional to the prevailing rate of water exchange. With the doubling of flushing time in the high pool, conditions for retention of the pelagic larvae are seen to be greatly improved. The less rapid passage of soluble nutrients carried into Passamaquoddy Bay by fresh-water runoff should enhance the supply of planktonic food for juvenile and adult scallops. A doubling of the sea scallop catch in the high pool is predicted, with an annual increase in the fishermen's earnings of about $700 (table 6).

Table 6.--Annual Quoddy Region sea scallop landings (meats) at present (10-year mean) and as predicted after dam construction

Area	Present		Predicted	
	Pounds	Dollars	Pounds	Dollars
Low pool	31,200	14,800	34,900	16,500
High pool	1,400	700	2,800	1,400
Total	32,600	15,500	37,700	17,900

Sea scallop populations are found only in the deeper portions of the low pool, so it is unlikely that anticipated changes in water level and salinity will adversely affect their survival. Landings in the low pool now account for over 90 percent of the total United States Quoddy Region sea scallop catch. These are expected to increase slightly because of the influence of warmer water. An annual increase of perhaps $1,700 in earnings is predicted (table 6).

SUMMARY

This study of the scallop fishery was part of the investigations on fish and shellfish, oceanography, and economics made in the Quoddy Region, in an attempt to evaluate the probable effects of the construction there of a hydroelectric tidal power project.

The scallop fishery is the second most important mollusk fishery in the United States Passamaquoddy project area. Average production during the period 1948-57 was over 32,000 pounds of meats valued at more than $15,000.

The most important changes anticipated in this area that concern the scallop would be the reduction in tidal water exchange, with attendant reduction in vertical mixing, the widened range of water temperatures, and the lengthened time of flushing in the high pool. In the low pool, water exchange and temperature will both be increased.

It is felt that conditions for sea scallop survival will be improved by the impoundment and that landings will increase. A prediction of doubled catches in the high pool is considered justified by the 50-percent reduction in water exchange. The increase in low pool catches will be comparatively small.

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