

SPAWNING LOCATIONS AND TIMES FOR ATLANTIC HERRING
ON THE MAINE COAST

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INTRODUCTION

Atlantic herring (*Clupea harengus*) deposit eggs on the bottom in the Gulf of Maine in the late summer and fall in depths of 30-300 ft (Sindermann 1979). Primary spawning grounds in the Gulf of Maine are located off southwest Nova Scotia, in the vicinity of Jeffreys Ledge, and along the eastern Maine coast (Bigelow & Schroeder 1953; Boyar 1968; Iles & Sinclair 1982; Haegerle & Schweigert 1985). Spawning has also been reported south of Grand Manan Island, at other locations along the Maine coast, and on Nantucket Shoals. Until the demise of the stock in the late 1970s, the largest spawning ground for herring in the Gulf of Maine was on Georges Bank, especially on the northern edge of the bank. Catches of fully mature herring and larvae on Georges Bank during 1986-1988 have indicated that this stock may be making a comeback.

Until 1983, evidence for herring spawning along the Maine coast was based solely on occasional reports from fishermen, the collection of recently-hatched larvae (Graham 1982), and samples of fully mature (ICNAF stage VI) adults caught by commercial vessels (Boyar et al. 1973). Preliminary attempts to document where and when herring were spawning along the eastern Maine coast were carried out in 1983 and 1984 in conjunction with larval research studies (Townsend et al. 1986). Interviews with local fishermen and a review of historical information resulted in documentation of a number of specific spawning sites along the coast (Stevenson 1984). Ten spawning episodes were reported in 1983 and 1984 in depths ranging from 120 to 150 ft; three sites were utilized in both years. Spawning was first reported in mid-August and lasted until mid to late September. Sightings were based on reports from lobster fishermen who haul lobster traps in this area of the coast with herring eggs sticking to them and reports from handline fishermen who catch cod at the spawning sites with their stomachs full of herring eggs. Additional information was collected from the fishermen during the next three years; some of this information has been presented (Stevenson 1986a/b; Stevenson & Knowles 1987; 1988), but detailed observations are not available and the most recent (1987 and 1988) information has not been compiled. Egg bed survey work in eastern Maine was significantly enhanced in 1985 and 1986 by the use of a remotely-operated underwater vehicle (ROV) which was equipped with a color video camera. The ROV was used to confirm sightings reported by the fishermen and to describe egg beds and spawning habitat. Results of ROV-assisted surveys were presented in Stevenson & Knowles (1987, 1988).

The purposes of this report are to summarize current and historical information which describes where and when herring spawn along the Maine coast, and to describe some of the physical characteristics of egg beds and spawning

habitat in eastern Maine as revealed by recent survey work. Information included in this report up-dates information presented for the eastern Maine coast for the years 1983 and 1984 and includes some results from the 1985 and 1986 egg bed surveys and two acoustic surveys for adults conducted in eastern Maine in 1987 and 1988. Previous reports of herring spawning locations and times (Stevenson 1984) were limited to the eastern Maine coast; this report up-dates the information for this section of the coast and extends the historical record west to the Boothbay region of the coast (Fig. 1). It does not include any reference to spawning in the vicinity of Jeffreys Ledge, another important spawning ground in the western Gulf of Maine located northeast of Gloucester, MA.

METHODS

Interviews

Interviews were conducted by the author with fishermen in Trescott, Cutler, Bucks Harbor, and Jonesport during the course of field work in eastern Maine during the 1985-88 spawning seasons. Most of these fishermen had provided information in previous years and were well known to the author. In many cases, the information was volunteered. Specific information concerning the exact location of traps with eggs attached to them, the number of traps with eggs, depth, substrate type, and the date when eggs were first observed was collected whenever possible. The precision of the information obtained varied considerably, depending primarily on how recently the eggs had been observed.

Interviews were also conducted by several Earthwatch volunteers (see Acknowledgements) who travelled to a number of fishing communities along the coast between Boothbay Harbor and Jonesport during July and August 1987 (Table 1). A total of 75 interviews were conducted in 17 different locations. Most of the fishermen who were interviewed were lobster fishermen, although herring cannery operators and fixed gear and purse seine fishermen were also interviewed. Herring fishermen and processors were selected on the basis of their knowledge of the herring fishery; lobster fishermen were selected according to either the area of the coast where they had traps or because they had been fishing for a long time. In several instances, the procedure was simply to select a particular dock and interview the captain of each boat as it unloaded.

Lobster fishermen were asked how long they had been fishing, what fishing grounds they were familiar with, where their traps were currently located, and if they had ever seen herring eggs on their traps. A preserved sample of eggs was shown to anybody who didn't know what herring eggs looked

like. Trap locations and egg sightings were noted in reference to a chart. If eggs had been observed, the interviewer asked for more details re. the year and time of year when the eggs were seen, water depth, substrate type, and the number of traps that eggs were seen on.

Information collected from herring fishermen was not as precise since their recollections of herring spawning areas were based on observations of mature adult herring either in fishing gear (usually purse seines) or as the fish were being removed from the gear. When someone reported having seen "spawn herring," they were asked if the fish were ripe and, if so, how they could tell. The best evidence was provided by fishermen who had seen eggs on the net twine or on the deck of the boat while the fish were being pumped.

All interviews were recorded on cassette tape and reviewed after the interview was completed. All positive reports of spawning were confirmed by the author, either from the tape, or, if there was any doubt, by a follow-up telephone interview.

Catch Sample Data

Data sheets on file at the Maine Department of Marine Resources for samples (50 fish per sample) caught by commercial fishing vessels during the period 1976-1986 were examined for evidence of adults in ICNAF maturity stage VI. Samples in which 20% or more of the fish had reached this stage, but were not yet spent, were identified and relevant information re. year, date, capture location, and gear were recorded.

RESULTS

Results are reported by location first for the years 1985-1988 and then according to historical accounts going back as far as the 1940s. In both cases, information based on egg sightings are differentiated from reports or samples of "spawn herring" caught in commercial fishing gear. Spawning sites are described starting at the eastern extreme of the Maine coast and progressing westward and are identified with reference to geographical landmarks. A letter code was assigned to each eastern Maine site which corresponds to locations shown in Figures 2 & 3. These same codes were used to identify individual spawning episodes listed in Table 2. Spawning locations mentioned in historical reports are shown in Figures 4 and a small-scale map (Fig. 5) shows details of a spawning site at Seal Island, in outer Penobscot Bay.

1983-88 Spawning Sites

Boot Head to Morton Ledge (Site A)

There was a large spawning along the coast in depths of 70-120 ft starting at Boot Head and extending two-thirds of the way towards the Morton Ledge buoy in late September 1988. One fisherman alone reported hauling about 40 traps with eggs on them; other fishermen fishing in the area also observed eggs on their traps. There were large numbers of 10-12 inch herring and dogfish in many of the traps. Purse seiners were working in the area at the same time.

Jims Head/Baileys Mistake (Sites B and C)

Spawning was reported at these two sites at different times during the 1985, 1986, and 1987 spawning seasons. The actual locations where eggs were observed were slightly different from year to year. Eggs were observed each year by local lobster fishermen and, in 1985, with the MINI-ROVER. Underwater video documentation of egg cover at site B in 1985 was the first time that the MINI-ROVER was used to survey an egg bed on the eastern Maine spawning ground. No spawning was reported at either of these two sites in 1983 or 1984 (Stevenson 1984) or in 1988.

Eggs were first observed attached to lobster traps located east (site B) and west (site C) of the red navigation buoy (2BM on the nautical chart) marking the entrance to Bailey's Mistake on September 6 1985. Several of these traps were hauled and shown to the author on September 9. Eggs were also reported on one or more traps at Boot Head. A school of herring was reported in the area on September 3. Eggs collected on September 9 were in an advanced state of development, indicating that spawning took place prior to September 6. Eggs collected on the 10th and 11th at site B started to hatch after they were transported to Cutler and observed under a microscope. Underwater observations on September 17 revealed only a few eggs remaining at this site, thus indicating that most of the eggs had hatched sometime between September 11 and 17.

MINI-ROVER survey work in 1985 was limited to the area east of the navigation buoy. Eggs were deposited in a continuous mat about an inch thick on a flat bottom composed of large shell fragments, sand, and gravel at a depth of 100 ft. A transect made with the vehicle in an easterly direction (starting at a point east of the buoy and running towards Boot Head) revealed continuous egg cover over a distance of approximately 800 ft. Benthic grab samples and other ROV dives indicated that this egg bed was not nearly as wide in an inshore-offshore direction as it was long. The perimeter of this egg bed, as viewed with the ROV at several locations, was quite distinct. One dive at the eastern edge

of the bed showed a fairly abrupt transition from heavy egg cover to small patches of eggs in an area where the substrate changed from a coarse shell, gravel, and sand mixture to a more uniform and finer sand and shell fragment substrate which had been worked into large "sand waves" by bottom currents. No eggs were observed attached to rocks in shallower water near the shoreline.

Eggs were reported attached to two lobster traps in 90 ft of water west of the navigation buoy in the entrance to Bailey's Mistake on August 18 1986; a few eggs were observed on two traps in 50-60 ft of water in the same location two days later. Eggs were still on the two traps in deeper water a week later. No eggs remained on any traps at this site on September 1. There was no spawning reported east of the buoy in 1986.

Herring spawned again west of the buoy in late September 1987. Five traps with eggs attached to them were hauled by one fisherman in 70 ft of water on September 28. Egg cover was heavy. Four days later (October 2), no eggs remained on these traps. A second fisherman was also reported to have seen eggs on traps in the same location.

Moose Cove (Site D)

A school of fish were observed on a sounder on August 23-24 1986 from Moose River Point west to Sandy Cove over smooth bottom in 80-120 ft of water. They remained in the area for 3 or 4 days. Eggs were reportedly seen attached to lobster traps in this location at about the same time, but not by the same fisherman who saw the fish. This was not very reliable information since no direct observations of eggs were reported.

Holmes Cove (Site E)

A few traps with eggs on them were hauled off the point of land on the east side of Holmes Cove on August 29 1985. Eggs were also reported on traps between Holmes Cove and Long Point on August 7 1986. No eggs were reported here in 1987 or 1988. Spawning at this site in 1985 and 1986 was apparently not very intense. No spawning was reported at this site in 1983 or 1984.

Long Point (Site F)

Heavy spawning occurred at this site in late September 1984 (Stevenson 1984). No spawning was reported at this location during any of the following four years. Ripe fish caught by a commercial purse seiner on September 25, 1984 in the Cutler area (Table 4) presumably belonged to this spawning group.

Little River Island/Fairy Head (Sites G and H)

Eggs were first seen attached to a few lobster traps located southeast of Little River Island in the entrance to Cutler Harbor (site G) and right up against Western Head, between the island and the mainland, on September 10 (or 11) 1985 by two fishermen. No eggs were reported in this location in 1983 or 1984 or during 1986-1988. One of these same fishermen also observed eggs on a few traps near the "Flat Rocks" off Fairy Head (site G), on the other side of the entrance to Cutler Harbor, at about the same time in 1985.

Limited MINI-ROVER observations of eggs and egg substrate were made between Little River Island and Western Head during several short dives on September 12, 1985. The eggs were present in small patches in a similar depth and on a similar substrate as was observed in 1985 at Jim's Head. Sediment samples collected in this area in 1985 and video observation of the bottom in 1987 indicated that substrate composition is highly variable; coarse gravel and shell fragments predominated in some locations, but there were also places where the substrate was composed of the same fine, rippled sand that was present at the edge of the egg bed at Jim's Head. Attempts to locate eggs near Fairy Head were not successful.

Two large schools of herring were observed by local fishermen with echosounders on July 19, 1987, one east of Western Head and another in the vicinity of Long Point. These fish were identified as herring by catching a few with hand jigs.

Great Head (Sites I and J)

Herring eggs were reported on about a dozen lobster traps at site J, located offshore of Great Head, along the 120 ft contour on August 5, 1986. Schools of herring were reported in the Great Head area in late July 1985, but the only eggs observed here at any point during the year were in a cod stomach on August 15. Ripe fish caught in the Cutler area in purse seines on August 9 and 19, 1985 (Table 4) probably spawned near Great Head. Spawning has also been reported along the coast between Great Head and Western Head (site I); eggs were observed on traps here on August 5, 1987. No spawning was observed at this site in 1988.

Deer Island (Site K)

Five lobster traps with eggs attached to them were hauled about halfway between the Black Ledges and the Old Man on July 29 1986. Spawning was not very heavy. A much more intense spawning occurred at this site on the night of September 22-23 1986. A large concentration of herring was observed in the area every night for about a week prior to spawning. Some herring were captured in a gill net 24 hours before spawning took place that were fully mature and ready to spawn.

The physical characteristics of the egg bed and the spawning habitat have been described in detail in Stevenson & Knowles (1987;1988); only a summary of those results is presented in this report. These observations were based on information provided by the fishermen, video documentation provided by MINI-ROVER, and samples of egg mat and bottom substrate collected by SCUBA divers and with a grab sampler operated from the surface. Surveying was continuous over the entire ten days between spawning and hatching. Eggs began hatching on October 2.

Eggs were deposited in varying densities over an area approximately 0.25 n mile^2 in size in depths varying from 60 to 100 ft. A continuous egg carpet up to 1 inch thick covered much of the area. The spawning area included a shallower portion due south and east of Deer Island (west of Great Head and within 500 ft of the coast) within a small "pocket" between the shoreline and three nearshore ledges (Deer Island ledges) and in a deeper portion west and outside of these ledges, closer to the Old Man and Cape Wash Island. Eggs at this site were attached to a variety of substrates. A thin veneer of eggs was observed on small rocks near the inshore edge of the bed and an egg carpet was deposited on shell fragments, gravel, and sand. Egg cover diminished fairly abruptly in shallow water inside the entrance to Little Machias Bay on a more uniform, sandy substrate and in rocky areas. Eggs appeared to diminish more gradually in number in deeper water at the offshore edge of the egg bed. Egg density estimates were higher in the deeper portion of the bed. The total number of eggs deposited at this site was estimated to be between 1.9 and 3.1×10^{12} and the total number of fish required to produce that many eggs was 38 to 62 million (or 9,100 to 14,900 metric tons). Egg mortality rates were negligible and there were no obvious differences in rates of egg development observed at the top and bottom of the egg mat.

There were apparently two spawnings at this site in 1987. The first occurred sometime in mid-August and the second in early October. Very little is known about the first spawning episode; on the second occasion, eggs were reported attached to lobster traps in the triangle formed by the Old

Man, Cape Wash Island, and the western end of the ledge which extends parallel to the shoreline offshore of Deer Island on October 5.

Two spawning episodes were reported from this site again in 1988, one in early August and another late in the spawning season, either in late September or early October. Neither spawning was very large. On the later occasion, traps with eggs on them were distributed over the same east-west distance, but somewhat more offshore. The fisherman who reported the late spawning at this location remarked on the reduced quantity of herring spawn seen in the Cutler area in 1988, compared with previous years.

Double Head Shot Islands (Site L)

Two fishermen reported herring eggs on lobster traps east of these islands in an area extending one-half to two-thirds of the distance from the islands to the Old Man in late August 1987. Egg deposition on the traps was not very heavy. Eggs were present on these traps on August 25 and August 27 or 28. No spawning was reported at this site in 1985 or 1986. Spawning did occur here in 1983 and 1984 (Stevenson 1984). A large concentration of fish were encountered in the area east of Cross Island and the Double Head Shots and west of the Old Man and Cape Wash Islands during an acoustic survey on the nights of August 31 and September 1 1988. Gill net catches of these fish revealed that they were spent adult herring. However, there were no reports of eggs in this location in 1988.

Cross Island (Sites M and N)

Heavy spawning was reported on lobster traps on the south side of Cross Island half-way between the Double Head Shots and the red navigation buoy at Seal Cove in 120 ft of water on August 18 1986 (site M). Eggs were also observed on traps in Seal Cove (site N) in August 1986 (specific date was not known). Eggs were reported on the south side of Cross Island and in Seal Cove in mid-August 1987 and again in Seal Cove at the end of the month (August 27-28). The quantity of eggs observed on traps in Seal Cove in late August 1987 was very low. Bucks Harbor fishermen were handlining cod which were feeding on herring eggs in Seal Cove in mid-August. One fisherman hauled lobster traps with eggs on them off Spruce Point (site M) on either August 22 or 23 1988.

Libby Islands (Sites O-T)

Eggs were observed attached to lobster traps at two sites south of the lighthouse on the "lower" island on August 28

1985. The "inshore" location (site Q) was only one-half mile from the island in 120-130 ft of water. The second location (site R) was determined to be one nautical mile southwest of the southwest tip of the island (compass bearing 228° magnetic; LORAN C 25746.4 and 12011.3). Depth at this location was 155 ft. The depth range in the area where the traps were located was reported as 150-180 ft.

Spawning was also reported at one other Libby Island site (S) located two nautical miles southeast of the lighthouse in mid-September 1985 (154° magnetic; LORAN C 12005.0 and 25739.3). Eggs were attached to traps over a distance of about one-fourth of a mile on either September 16 or 17. Depth at this location on the chart is over 180 ft.

Eggs were only reported from one Libby Island site in 1986. This site (P) was located about 1 1/2 miles east of the lighthouse in 120-150 ft of water. Eggs were first observed on traps at this site on September 8 and were apparently spawned the night before. Observations of eggs at this site were made with the MINI-ROVER on September 9 and 10. Traps with eggs on them were located 0.8 n miles apart in a northeast-southwest direction, but it is doubtful that egg cover was continuous over that distance. Eggs were observed in a carpet similar to that seen in other locations, and on a similar substrate, during several dives. Survey work was interrupted after the first two days by a storm; upon resumption of ROV surveying on September 14, no eggs could be found. More information concerning this egg bed is presented in Stevenson & Knowles (1987;1988).

Spawning was reported by two lobster fishermen at two "new" Libby Island sites in late August 1987, i.e., two sites where eggs were not reported in any of the previous years. Spawning was not reported at any of the "old" sites in 1987. One sighting was on 8-10 consecutive traps southeast of the "upper" island (site O) in a line running for about half a mile toward the lighthouse in 120 ft of water on August 24 (LORAN C 25747-48 and 11993-94). The other sighting (site T) was about 3/4 of a mile southeast of the lighthouse between sites P and Q. The exact date when these eggs were seen is uncertain; it was between August 24 and 27. Eggs were observed on 10-20 traps; many of them were "plastered" with eggs.

Herring eggs were observed on lobster traps at or near the three sites southeast and southwest of the Libby Island light house (sites L, Q, and T) in the latter part of August 1988. No spawning was reported from any of the other Libby Island sites in 1988. Eggs were seen on ten traps along the 25747 line between 12007 and 12009 during the week of August 15; these eggs were still present the following week. Traps hauled on the 12000 line between 25747 and 25748 in 20-22 f on August 20 were "loaded up" with eggs and some of them had

10-14 inch herring inside. These same traps were devoid of eggs on August 29. There were also eggs reported on traps running from 12005 southwest to about 12010 on the 25744 line on or near August 24 which were still present in very reduced numbers a week later.

These reports of spawning activity within a mile of the light house during the third and fourth weeks of August 1988 were corroborated by the results of an acoustic survey conducted in the eastern Maine spawning ground in late August and early September 1988 (Nash & Geffen 1989) which revealed several schools of herring in the same location on the night of August 22-23. Fish caught in a gill net from one of these schools were fully mature and ready to spawn.

Smith Reef (Site U)

Eggs were observed on lobster traps on the northern end of Smith Reef (located 2 1/2 miles from the Libby Island lighthouse, 190° magnetic, LORAN C 12018 and 25737.5) on September 19 1985. Eggs were reported to be deposited over a smaller area than they were at site O on September 16-17 1985. The depth here is about 110 ft. No spawning was reported on Smith Reef in 1983 or 1984, nor during 1986-88, although it has been mentioned as a location where herring have spawned in the past (Stevenson 1984).

Scabby Islands (Site V)

Eggs were observed on traps here in early September 1983, but not subsequently.

Ram Island (Site W)

One lobster fisherman reported heavy spawning between Scabby Island and Ram Island (LORAN C 12005 to 12004.3 and 25750 to 25753) in 100-130 ft on September 3 1987. The egg cover was thick, even on lobsters in the traps and there were live adult herring containing spawn in some of the traps. There were no eggs on these traps two days earlier. The bottom at this location was reported to be "shelly" with scallops.

Rogue Island (Site X)

Several fishermen from Jonesport reported hauling a large number of traps with eggs on them east of Rogue Island inside a triangle formed by Halifax Island, the Brothers, and Pulpit Rock on September 12 1988. The quantity of herring spawn that was observed in this area was more than many of them had ever seen before. Herring have not spawned in this location for some time (see section on "historical egg sightings").

Seal Island (Penobscot Bay)

Herring eggs were reported attached to lobster traps at several locations in the vicinity of Seal Island (see Fig. 5) in outer Penobscot Bay in 1986 and 1987 by two fishermen from Vinalhaven. This is an important spawning site in mid-coastal Maine where eggs are usually seen every year (see "historical egg sightings"). The absence of any information on spawning here in 1985 simply reflects the fact that lobster fishermen who have traps in this area were not contacted and interviewed until the summer and fall of 1987; specific information obtained at that time only related to the previous two years.

Spawning in 1986 was reported to have occurred on the Gully Shoals between Seal Island and Malcolm Ledge (LORAN C 12680 between 25760 and 25770) "probably" in mid-September. Eggs were seen on two strings of traps and lasted for 2-3 days. Eggs were reported to be spawned at this location "every year." A second location was on the eastern side of Seal Island on a hard, rocky bottom in 90-110 ft. Small bunches of eggs were observed here on some traps.

Eggs were also reported in two locations near Seal Island in 1987. One was in a "cove" (Murr Cove) on the south side of Eastern Ledge, at the eastern end of the island, and the other was on the northern side of the same ledge. The eggs were seen on two occasions, on September 26 and again on September 29. Spawning was reported to be light in 1987. Eggs were seen on only one string of traps north of the ledge. Herring were seen at the surface between Three Fathom Ledge and Malcolm Ledge a few days before they spawned.

No eggs were reported from Seal Island in 1988. Several schools, presumably of large herring, were observed off the southwest end of the island during an acoustic survey on the night of September 21-22.

Pemaquid Point

One lobster fisherman reported seeing herring eggs on a few traps near shore half-way between Yellow Head and Pumpkin Cove on the eastern side of Pemaquid Neck in the fall of 1986; another fisherman reported seeing eggs in bunches on a few traps between Yellow Head and Pemaquid Point at the same time. Specific dates were not given. Reported depths were 82 ft and 60 ft, respectively, and bottom types were sandy with small rocks and sandy. Spawning has not been reported in this location during any other year, either recently or historically.

Historical Egg Sightings

Eastern Maine

There are historical reports of herring spawning offshore of Roque Island, but they are conflicting. One fisherman noted that herring had spawned regularly in this area for four or five years in the early 1960s, but that nothing had been seen here since then. Other reports state that eggs were seen on traps in this area about 15 years ago and again a couple of years later, on a gravel/rocky bottom. Another location was vaguely mentioned as being 5-6 miles off Libby Island and Black Head (Head Harbor Island) 7-8 years ago over a distance of about a mile on a sand and gravel bottom.

Schoodic Ridges

A purse seiner who used to set lobster traps at this location, at a depth of 240 ft about 17 miles southeast of Schoodic Point (LAT 44°08', LONG 67°49'), reported having seen herring eggs on his traps 10-15 years ago over a period of several years. He also reported that nobody is lobstering there now, which would account for this location not being mentioned as a currently active site. Cod fish have been caught here with herring eggs in their stomachs. This is the only definite report known of spawning at a deep offshore site along the coast.

Mt. Desert/Swans Islands

Herring eggs were seen 30 years ago on the south side of Great Cranberry Island in an area 1 to 1.5 miles long and 200 yards wide from Dolly Hill to a spot just west of Rice Point. The bottom was described as "completely white" with eggs. Another area that was mentioned was between Black Island and Great Duck Island, south of Mt. Desert Island.

Penobscot Bay

Eggs were observed on traps "in a deep hole" (Blue Cove) between Criehaven and Wooden Ball Island (Fig. 5) for 4-5 years in the late 1940s and early 1950s. Depths in this area range from 180 to 380 ft. One specific time given was July or August, 1947. Seal Island was also mentioned as a place where herring spawn "every year." Herring reportedly "used to spawn" on the north side of this island "all over" in only 30-35 ft of water; it was a "regular thing," but has not been seen in ten years.

White Islands/Pumpkin Islands

Historical reports of spawning were obtained from the area east of these islands (and their associated ledges). One report made reference to spawning east of Pumpkin Island 10

years ago in 90-120 ft in "the gully" on a broken rock and mud bottom. A second report was at White Island "many years ago" and a third in the same area on sandy bottom 20 years ago. One lobster fisherman distinctly remembered seeing herring eggs on his traps in this area in 1965.

"Spawn Herring"

Perry Shore

Two samples from weir catches in late September 1980 on the Perry Shore (Table 4) indicate that herring spawn along this 10 mile stretch of coastline inside Passamaquoddy Bay between Eastport and the mouth of the St. Croix River.

Libby Island-Cutler

Ripe herring are caught fairly routinely by purse seiners along the coast on the eastern Maine spawning ground in various locations. One seiner reported seeing a lot of spawn herring on Smith Reef in 1986. Ripe herring were caught in purse seines near Cutler in late September 1984 and mid-August 1985 (Table 4).

Moose Peak

There is an area of shoals located 5-10 miles southeast of the lighthouse at Moose Peak (near Jonesport, see Fig. 4) where adult and juvenile herring are seined. One fisherman described the fish as staying within an area bounded by 25715-720 and 12120 to the low 80s, i.e., an area about 1 x 5 miles in size. He reported catching fish on a shoal at 12085 and 25719 on the night of 8/5/87 when he saw 40 fathoms of fish over a distance of 1/4 mile. He said that he catches both adults and juveniles off Moose Peak and that he sees spawn herring here every year. He has fished here until late October when the weather gets bad, but "there are still plenty of fish" then. He is certain that herring that spawn off Moose Peak and on the Schoodic Ridges "head for Grand Manan" after they spawn.

Schoodic Ridges

In addition to reports of herring eggs on lobster traps here 10-15 years ago, spawn herring are also seined here. They were reported here in late July and early August of 1987. They arrive in early July. ("You can set your watch by those herring"). One fisherman said that he believes that the fish are getting ready to spawn when they don't come up off the bottom at night. Gill netters also fish in this area. The bottom here is reported as "hard" with depths of 210-240 ft.

Mt. Desert Rock

Adult fish and juveniles are seined around this rock, but one fisherman reported that the adults are usually spent (i.e., they have already spawned) and are moving westward. Mixed catches of adults and juveniles apparently are common in this location.

Bakers/Great Duck Islands

Spawn herring were seined in this area on several occasions by one fisherman during the spawning closure in September 1987 and had to be released. Spawn herring were caught on the east side of Great Duck Island in 150-180 ft in 1987 and 1986. A sample of ripe herring was collected from a purse seiner that was fishing near Bakers Island on August 29 1986 (Table 4).

Marshall Island

This island (located west of Swans Island) was mentioned by several people as a place where spawn herring used to congregate. It was "always noted for spawn herring." One fisherman referred to the late 1940s and early 1950s and another said there hasn't been anything there for the last 6-7 years. The "sound" on the southeast side of the island between the island and Mason Ledge was specifically mentioned.

Penobscot Bay

Several places in Penobscot Bay were mentioned. Spawn herring are seen around Seal Island (Fig. 5) on a fairly regular basis. A large group of adults remained on the western end of Seal Island for about a month in September 1985, in an area extending from shore out to 120 ft. Spawn herring were seen around the island in 1986 as well, when eggs were observed on lobster traps. Matinicus Rock was also mentioned as a place where spawn herring are caught in purse seines.

Spawn herring were caught in purse seines in the "gully" between Criehaven and Wooden Ball Island in the late 1940s and early 1950s at the same time when eggs were seen on lobster traps in the same area.

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REFERENCES

- Bigelow, H.B. and W.C. Schroeder 1953. Fishes of the Gulf of Maine. Fish. Bull. 74, U.S. Fish & Wildl. Serv., Vol. 53, 577 p.
- Boyar, H.C. 1968. Age, length, and gonadal stages of herring from Georges Bank and the Gulf of Maine. Res. Bull. Int. Comm. Northw. Atl. Fish. 5:49-61.
- Boyar, H.C., R.R. Marak, F.E. Perkins and R.A. Clifford 1973. Seasonal distribution and growth of larval herring (*Clupea harengus* L.) in the Georges Bank - Gulf of Maine area from 1962-1970. J. Cons. Int. Explor. Mer 35:36-51.
- Graham, J.J. 1982. Production of larval herring, *Clupea harengus*, along the Maine coast. J. Northw. Atl. Fish. Sci. 3:63-85.
- Haegeler, C.W. and J.F. Schweigert 1985. Distribution and characteristics of herring spawning grounds and description of spawning behavior. Can. J. Fish. Aquat. Sci. 42(Suppl. 1): 39-55.

Iles, T.D. and M. Sinclair 1982. Atlantic herring: stock discreteness and abundance. *Science* 215: 627-633.

Nash, R.D.M. and A.J. Geffen 1989. Acoustic assessment of herring in the eastern Gulf of Maine 1988: Survey 2 (August 22-24 1988). *Mainely Fish, Research - Rep. Doc. 89/1 A*.

Sindermann, C.J. 1979. Status of northwest Atlantic herring stocks of concern to the United States. NOAA/NMFS Northeast Fish. Ctr., Sandy Hook Lab., Tech. Ser. Rep. 23:449 p.

Stevenson, D.K. 1984. Spawning locations and times for herring (*Clupea harengus* L.) in coastal waters of eastern Maine. *Maine Dept. Mar. Res., Res. Ref. Doc. 84/1:34 p*.

_____ 1986a. Good data in herring egg bed study. *Comm. Fish. News*, April 1986, p. 10.

_____ 1986b. The humble herring: gold-plated sardine. *Explorations, A journal of research at the Univ. of Maine*, C. Bombard (ed.), Jan. 1986:21-25.

_____ and R.L. Knowles 1987. Physical characteristics of herring egg beds on the eastern Maine coast. *ROV '87 Proc.*, San Diego CA, March 10-12 1987.

_____ 1988. Physical characteristics of herring egg beds on the eastern Maine coast. In: Babb, I. and M. DeLuca (eds.), *Benthic productivity of the Gulf of Maine*, National Undersea Research Program Res. Rep. 88-3:257-276.

Townsend, D.W., J.J. Graham and D.K. Stevenson 1986. Dynamics of larval herring (*Clupea harengus* L.) production in tidally mixed waters of the eastern coastal Gulf of Maine. In: *Tidal mixing and plankton dynamics*, M. Bowman, C. Yentsch and W.T. Peterson (eds.), *Lecture notes on coastal and estuarine studies*, Springer-Verlag, 17:253-277.

Table 1: Number of interviews conducted, by port, July-August 1987.

<u>Port/Community</u>	<u># Interviews</u>
Corea	2
Steuben, Pigeon Hill	5
Prospect Harbor	1
Milbridge	2
Southwest Harbor	1
Winter Harbor	1
Stonington	5
Jonesport, Beals Island	18
Rockland	1
Tenants Harbor	6
Matinicus	4
Vinalhaven	5
Port Clyde	5
Friendship	10
South Bristol	2
New Harbor	4
Boothbay Harbor	3
	<hr/>
Total	75

Table 2: Summary of herring egg bed locations and estimated spawning times in eastern Maine coastal waters, 1983-1988.

Site	Location	1983	1984	1985	1986	1987	1988
A	Boot Head- Morton Ledge	ns	ns	ns	ns	ns	late 9
B	Jim's Head- Boot Head	ns	ns	9/6	ns	ns	ns
C	Bailey's Mistake	ns	ns	9/6	8/18-20	9/28	mid or late 8
D	Moose Cove	ns	ns	ns	late 8	ns	ns
E	Holmes Cove	ns	ns	8/29	8/7	ns	ns
F	Long Point	ns	9/27-28	ns	ns	ns	ns
G	Fairy Head	ns	ns	9/10-11	ns	ns	ns
H	Little River Is	ns	ns	9/10-11	ns	ns	ns
I	Great Head (inshore)	ns	ns	ns	ns	8/5	ns
J	Great Head (offshore)	8/23-24	8/18	8/15?	8/5	ns	ns
K	Deer Island	ns	ns	ns	7/29 9/2	8/5 mid 8	early 8 late 9?
L	Double Head Shot Is.	9/8	8/22-25	ns	ns	8/25	ns
M	Cross Is. (south shore)	ns	ns	ns	8/18	8/12?	8/22-23
N	Cross Is. (Seal Cove)	9/14	ns	ns	** 8/27-28	8/12?	ns
O	Libby Islands	ns	ns	ns	ns	8/24	ns
P	Libby Islands	ns	9/17	ns	9/9	ns	ns
Q	Libby Islands	**	9/7	8/28	ns	ns	8/20
R	Libby Islands	ns	ns	8/28	ns	ns	8/15-19
S	Libby Islands	ns	ns	9/16-17	ns	ns	ns
T	Libby Islands	ns	ns	ns	ns	8/24-27	8/24?
U	Smith Reef	ns	ns	9/19	ns	ns	ns
V	Scabby Islands	early 9	ns	ns	ns	ns	ns
W	Ram Island	ns	ns	ns	ns	9/3	ns
X	Halifax Island	ns	ns	ns	ns	ns	9/12
Total spawning episodes		5	5	10	9	11	9

Key: ns = no reported spawning; ** = spawning date unknown;
? = uncertain spawning date.

Table 3: Areas where herring eggs have not been observed, as reported by lobster fishermen interviewed July-August 1987.

<u>Home port</u>	<u>Location</u>
Corea, Prospect Harbor Steuben, Pigeon Hill	Southeast of Schoodic Point 10-12 mi out from Pigeon Hill Bay, in Dyer and Gouldsboro Bays
Milbridge	Pleasant Bay, Narraguagus Bay out to Petit Manan
Winter Harbor	Bar Harbor side of Mt. Desert Is. out to outer Frenchman Bay
Stonington	East side of Penobscot Bay between Vinalhaven and Stonington, Isle au Haut Bay
Jonesport	Eastern Bay, Western Bay to Petit Manan
Tenants Harbor	Southeast of Tenants Harbor to Matinicus, Matinicus Rock including area west of Metinic Is.
Port Clyde	South of Port Clyde, east of Monhegan Is.
Friendship	Muscongus Bay out to Moser Ledge, west of Monhegan Is.

Table 4: Incidences of more than 50% "ripe" herring (ICNAF Stage VI) in samples obtained from the commercial fishery and processed at the DMR laboratory in Boothbay Harbor, 1976-1986.

<u>Date</u>	<u>Location</u>	<u>Gear</u>	<u># Females</u>	<u># Males</u>
9/24/80	Perry shore	Weir	16	16
9/28/80	Perry shore	Weir	7	14
9/25/84	Cutler	PS	25	19
8/9/85	Cutler	PS	9	3
8/19/85	Cutler	PS	11	3
8/29/86	Bakers Island	PS	13	12

FIGURE CAPTIONS

Figure 1: The Gulf of Maine with insets showing sections of the gulf included in Figures 2-5.

Figure 2: Eastern Maine coast, West Quoddy Head to Long Point, showing spawning sites A-E.

Figure 3: Eastern Maine coast, Long Point to Roque Island, showing spawning sites F-X.

Figure 4: Maine coast from Moose Peak to Cape Small showing locations mentioned in text.

Figure 5: Detailed map of area around Matinicus Island in outer Penobscot Bay showing 30 ft depth contour.

FIGURE 1

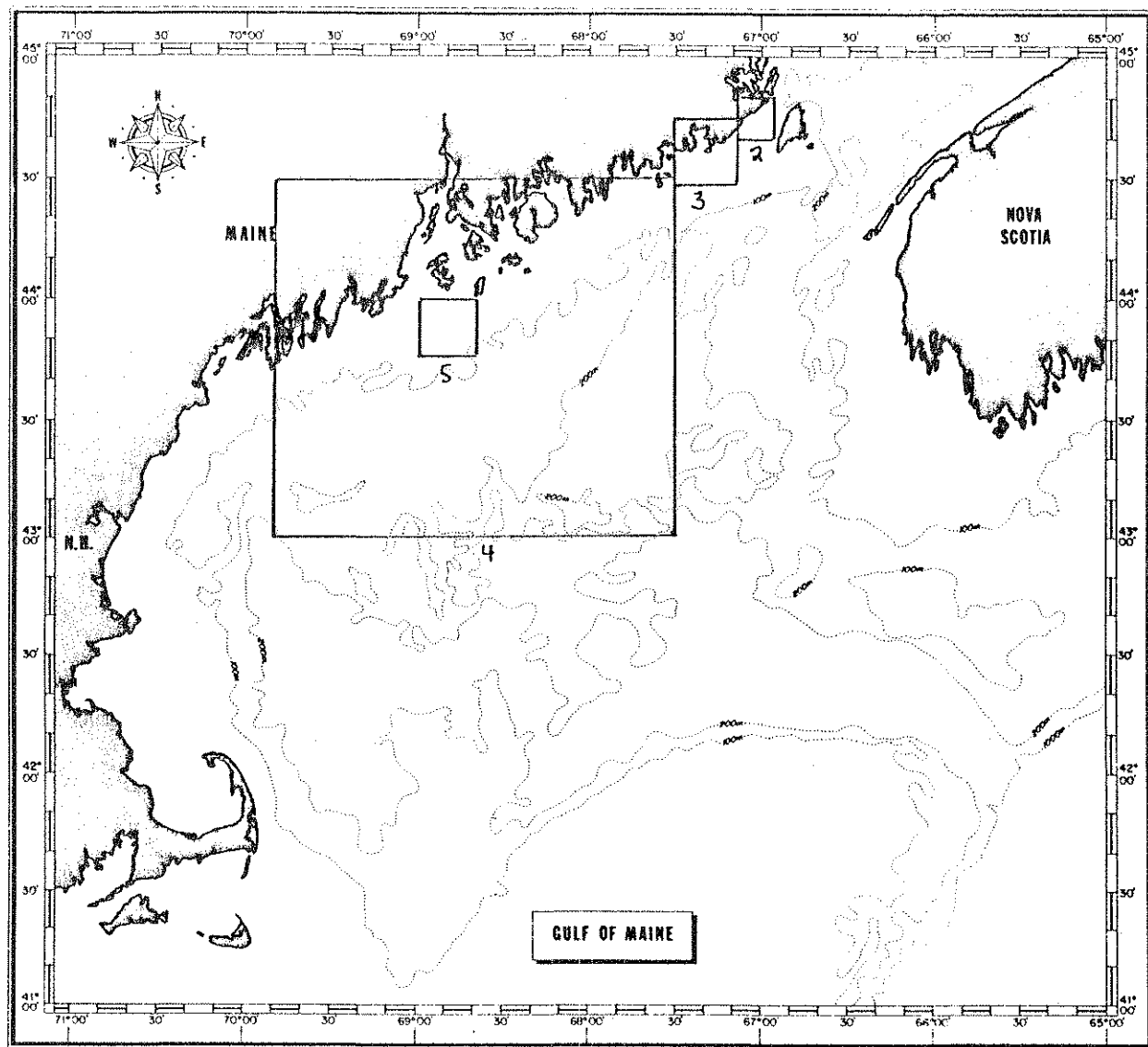


FIGURE 2

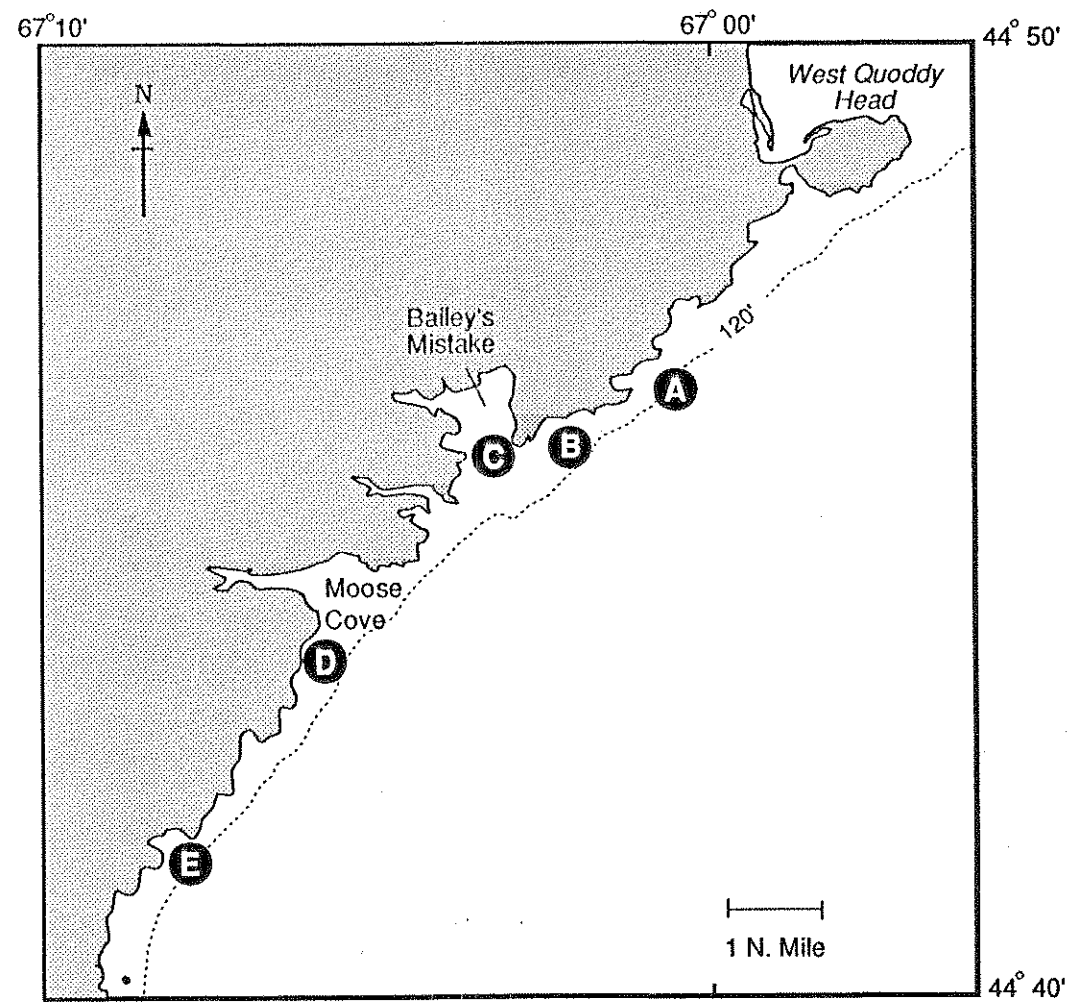


FIGURE 3

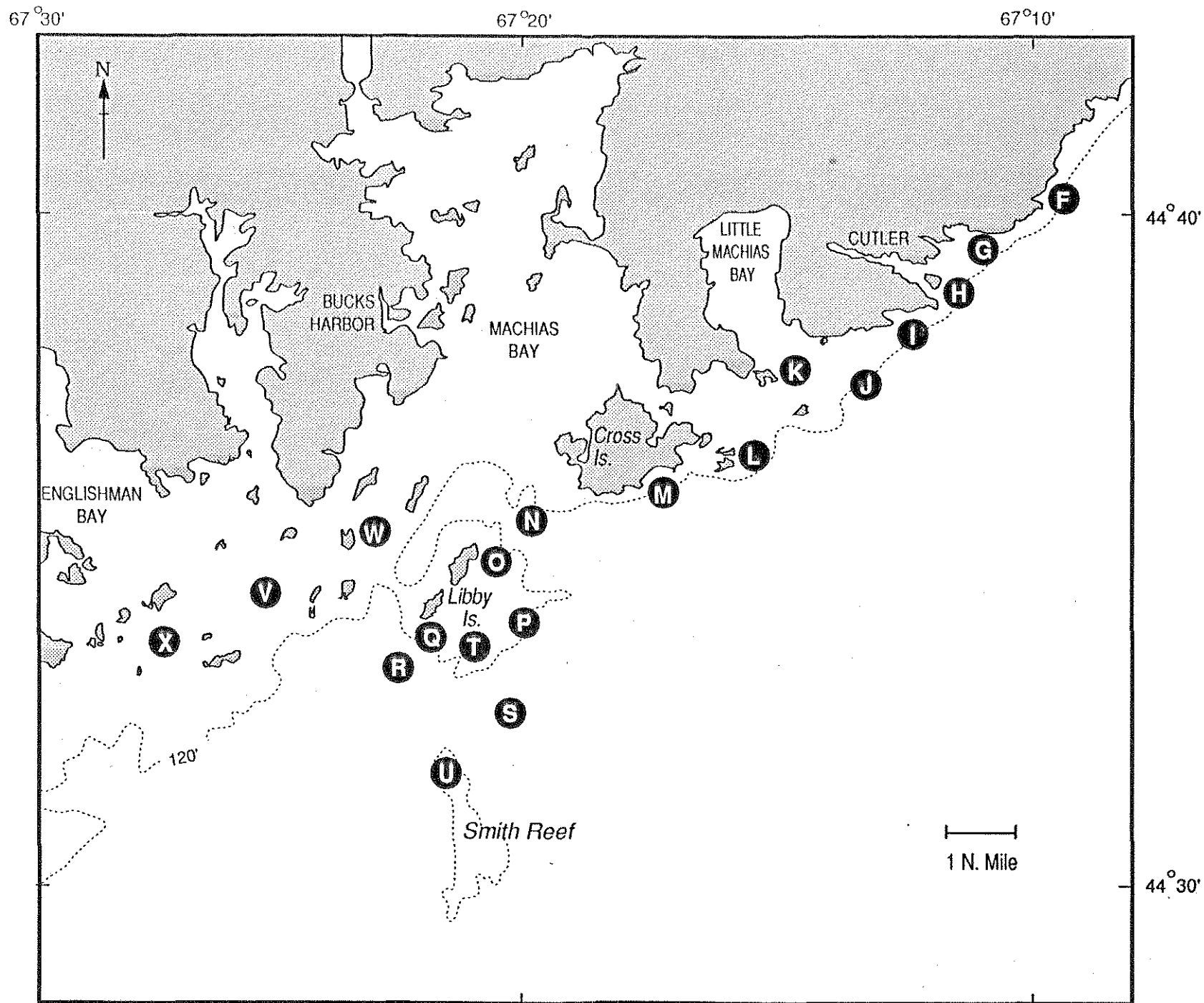


FIGURE 4

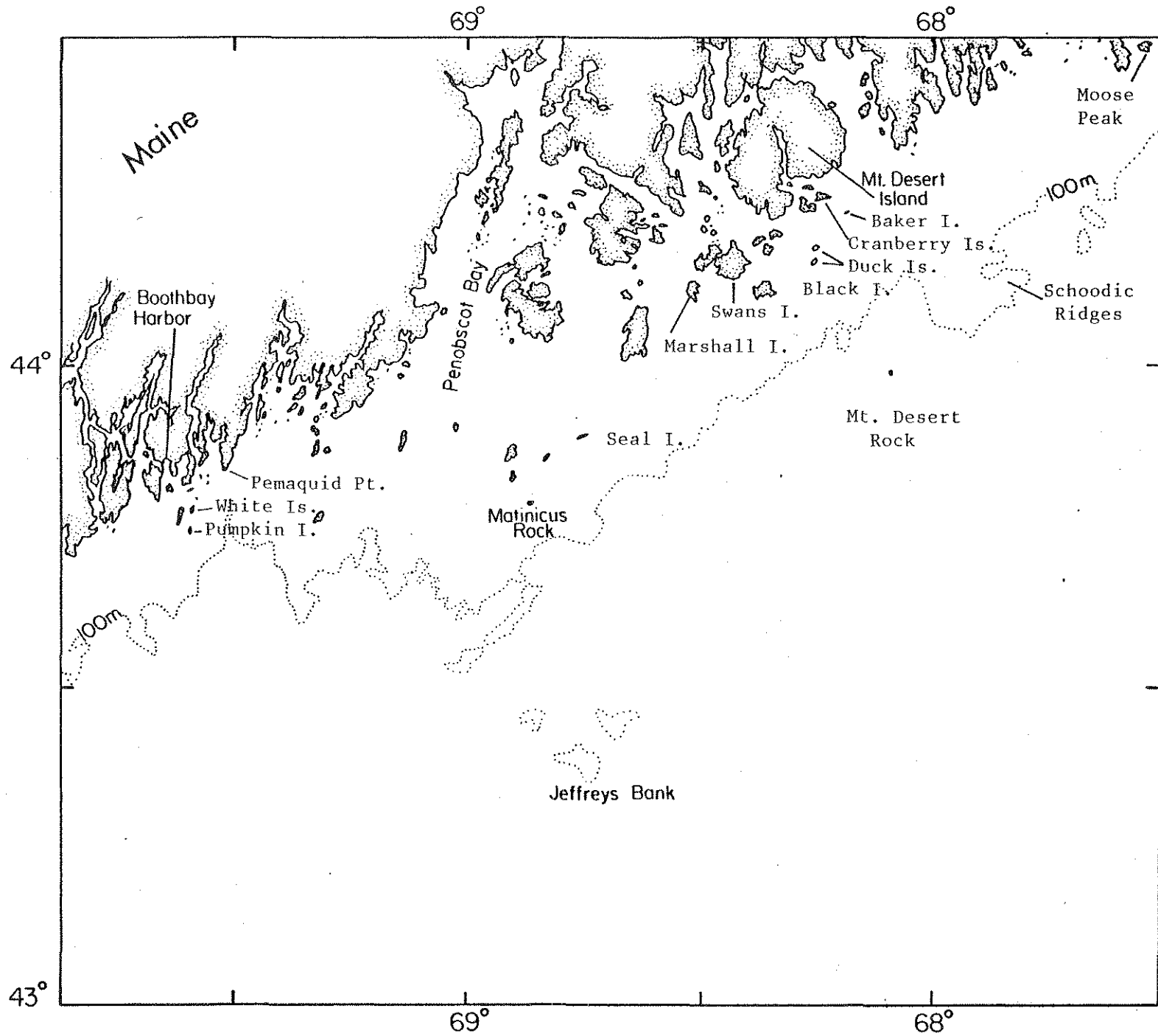


FIGURE 5

