



Eastern Gulf of

Maine Atlantic

Herring Spawning Area Survey

Project Year 6 Summary

*Identifying spawning habitat of *Clupea harengus*
in coastal eastern Maine and Grand Manan, New Brunswick*

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EXECUTIVE SUMMARY

Six years of field observations of Atlantic herring spawning events in the inshore waters of eastern and central Maine and on Grand Manan Island, New Brunswick, combined with two years of interviews with fishermen concerning the timing, extent and locations of historical spawning events, have indicated the following possible changes in behavior and abundance of coastal Atlantic herring:

- A reduction in the number of yearly spawning events, perhaps indicating an overall decline in coastal herring spawning in the last two decades.
- It appears that adult and juvenile herring are no longer as abundant as they once were in parts of their full range, particularly along the inshore waters of the Maine coast.
- The six years taken in aggregate present a picture of temporally later spawning events of reduced extent, number, and volume, while still geographically centered on the traditionally identified core areas of downeast Maine and New Brunswick.

Atlantic herring are, however, a highly migratory fish, and it should be recognized that local lack of abundance does not conclusively indicate a substantially depressed local stock. The population may have shifted to another region for any of a vast number of environmental reasons.

Four spawning events were recorded during the 2002 field observations, running from August 24 to the 15th of October. These events were all in the Cutler area. Some of the events were observed in deeper than usual water, with project field coordinator and fisherman Stillman Fitzhenry suggesting that the deeper water spawning might be in reaction to warmer water temperatures. No events were recorded in the western regions of the study.

INTRODUCTION

Atlantic herring is one of the keystone species of the Gulf of Maine, both ecologically and economically. Ecologically, many marine species depend on herring, including marine mammals, sea birds, and predatory fish. Economically, the herring fishery has an impact as Maine's largest single fishery by weight, with recent yearly landings over the last five years averaging over 100 million pounds (Maine DMR, 1999). As well as providing fish for the sardine industry, the fishery provides a major input to the lobster fishery, as a large part of the bait currently used by lobstermen is locally caught herring.

Herring landings in the Gulf of Maine coastal area (referred to as Area 1A for herring management, this area includes the coastal waters of Maine, New Hampshire, and part of Massachusetts) have been increasing steadily since 1989. The Maine portion of the catch has gone from 15,625 metric tons in that year to approximately 62,000 metric tons for the 2000 fishing year (Maine DMR, 2000). While these figures do not exceed historical records for Maine herring landings, which peaked in the years around the turn of the century, and again in the late 1940's, at around 75,000 metric tons, they do indicate a recently increasing pressure on the Gulf of Maine stock. Reports from inshore lobstermen and fixed gear herring fishermen interviewed for this project suggest an overall drop in the abundance of inshore fish, with fewer sightings of juveniles close inshore in the coves in the summer and fall, and less spawning alongshore in the late summer and autumn. An inshore decline in herring could have a serious effect on the entire coastal marine ecosystem, affecting both natural and human communities.

The Island Institute's herring spawning assessment project sought to use a network of fishermen to collect information on herring spawning activity in nearshore waters. The project aimed to locate and record the sites, times, and size of specific Atlantic Herring spawning events on the mid and eastern Maine coast. The Atlantic States Marine Fisheries Commission has prioritized the identification of spawning areas as a primary research need for the protection of Atlantic herring, and has noted concern that current levels of exploitation could threaten smaller localized spawning populations in the Gulf of Maine (New England Fisheries Management Council, June, 2000). Comparison of this recent information on herring spawning volume and times to historical records offers an insight into changes that may have occurred in the behavior and abundance of this stock. Information about the size and depth of the egg mats can be used to estimate overall herring spawning success and spawning stock size, and the relative times of spawning over many years could reflect behavioral changes of the species to both natural and human pressures.

METHODOLOGY

Herring spawning is generally recognized to begin in Nova Scotia, New Brunswick, and eastern Maine in August, with activity moving south and west down the coast as autumn progresses, continuing as late as the end of November on Nantucket Shoals and Georges Bank, the southernmost limit of spawning (Bigelow and Schroeder, 1953). The period of observation for the area of this study was from mid-August to the first of November, covering what is believed to be the current period of maximum spawning. It is noteworthy that this selected period is later than the peak spawning period indicated in some historical records, possibly indicating a fairly recent change in spawning behavior, with spawning events taking place somewhat later in the year (Stevenson, 1984, 1989). The selection of this time frame is based upon contemporary interviews with fishermen, and there has been no indication in the four years that events have been missed due to their having taken place before the observations began.

Habitat favored by herring for spawning consists of rock, gravel, or sand bottoms, commonly ranging in depth from 50 to 200 feet (Haegele, 1985), with the average in this study around 120 feet. Females produce from 20,000 to over 100,000 eggs each, which are heavier than water, and covered in a sticky mucous. The eggs will sink to the bottom and stick in clumps or layers to the bottom, seaweed, lobster gear, or any other substrates they settle upon. A large school

can produce so many eggs that the bottom will be covered in a fairly continuous and measurable egg mat. The eggs have a gestation period of eight to fourteen days, depending on water temperature, and after hatching all traces of the event disappear rapidly. It is during the period that spawn is on the bottom that the sampling takes place, with microscopic observations of the developmental state of the eggs giving an estimate as to when the spawning may have taken place.

The study area covers the inshore area from the Vinalhaven region, to the nation's eastern extremity, West Quoddy head. This region was chosen based on historical records of high herring spawning productivity (Bigelow and Schroder). Also impacting the study boundaries was a series of interviews with area fishermen attempting to determine current spawning sites. All of the events that have been reported have been within three nautical miles of the shoreline.


Spawning events are detected as they occur through a reporting network of local lobstermen and herring fishermen. To alert community fishermen, outreach is conducted through informational posters at lobster pounds, and direct contact in the fishing community by the paid local research partners, who are all themselves fishermen. Lobster fishermen have shown interest in the herring spawning project because of their interest in a sustainable bait resource and fishery in the coastal waters. Lobster pots are used as effective monitoring devices without any changes in design or use, as the herring eggs will stick to the pots even when they are hauled. Fishermen having herring spawn on their gear are requested to report the location and time

to either the Island Institute or their local project partner, whereupon the local research partner will go to the site and record with bottom testing gear (a small hand drag) the extent of the event, the thickness of the egg mat, the substrate, and the water depth. Both positive and negative sites are recorded, thus defining the area of the event. The bottom gear also brings up a small bottom sample, and substrate characteristics are thus recorded. In areas where there is no lobstering during the herring spawning season, purpose-specific egg collectors have been deployed and tended by local fishermen. Grand Manan, New Brunswick, and Monhegan, Maine were covered in this fashion in past years of the study. Locations and physical attributes were collected in the first three years by differential GPS datalogger, and by regular GPS in the fourth year; the differential processing unit was no longer needed due to a national upgrade in the accuracy of the standard system. Each year hard copy records were kept to capture any additional incidental information, such as the locations of feeding whales, and were also used to verify the digital data.

LOBSTERMEN - PLEASE REPORT
the location of any observation of
Herring Spawn
 using Loran C or GPS coordinates, to the closest person:

Stillman Fitzhenry, Cutler
 Home (207) 259-3961
Kristan Porter, Cutler
 F/V Whitney and Ashley, Channel 13
 Home (207) 259-3306
Junior Backman, Beals
 Home (207) 497-5429
Ben Neal, Island Institute, Rockland
 (207) 594-9209 ext. 102

This is a multi-year continuing project observing the extent of coastal herring spawning activity in downeast and mid-coast Maine. Coastal herring spawning appears to have decreased in the last decade in much of coastal regions. This study will match recent spawning observations with historical information to determine changes in herring spawning areas and abundance. This information has been used for the purpose of developing sound herring conservation and fisheries plans. This project has received support from the Downeast Lobstermen's Association and the Maine Lobstermen's Association. Your input would be very much appreciated. For more information please call the Island Institute in Rockland, (207) 594-9209



The clump of herring eggs above is about 3 inches long.
 Herring eggs may appear in clumps of varying size or as single eggs attached to traps.

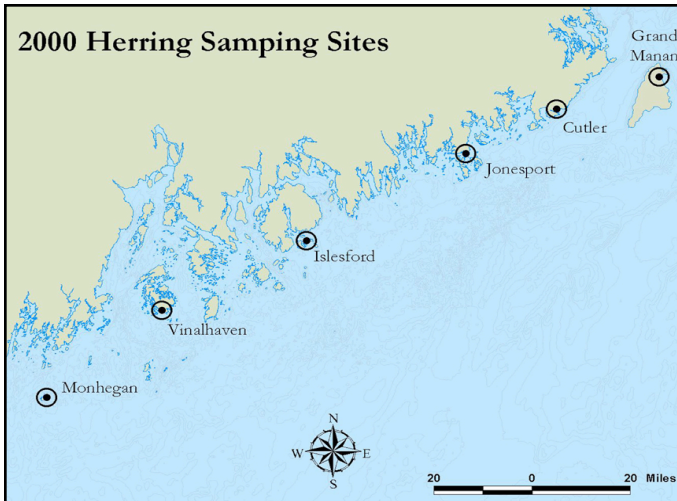
If you see herring eggs on your traps please note the following:
 - your location using Loran C or GPS

PROJECT REVIEW

2002 was the sixth consecutive year of this project. The first year, 1997, focused on the area from Jonesport to West Quoddy Head, with the project leader, retired lobsterman Stillman Fitzhenry, living in Cutler. Fitzhenry interviewed 25 local fishermen that year to determine areas where the spawn had historically been present, gathering information primarily on the years 1994-1997. Through these interviews Fitzhenry also raised public awareness of the goals and methods of the project, and asked fishermen to report to him any sightings of herring eggs on their traps. Several steps were taken to reach as many fishermen as possible. Members of the Downeast Lobstermen's Association, the Maine Lobstermen's Association, and the Maine Sardine Council were all briefed on the project and the identification of herring eggs. Flyers describing the project were posted at co-ops in the Cutler and Jonesport areas, and Maine DMR and the Island Institute conducted an informational meeting in Jonesport-Beals Island. Monitoring of actual events was also initiated that year, and three spawning events were detected and sampled (Brehme, 1998). A total of 139 samples were taken on 108 separate sites. The first year's conclusions advanced the hypothesis that herring spawning was taking place in a greatly reduced fashion in the study area.

The second year of the project, 1998, was supported in part by the National Marine Fisheries Service. Two spawning events were recorded in this year, with fisherman Herman Backman Jr. joining the project to monitor the area around Jonesport. Both events took place off Cross Island, and no spawning was observed in the region from Cutler to West Quoddy Head.. The 1998 project year also brought increased cooperation with Dr. David Stevenson, herring biologist with the Maine Department of Marine Resources, who performed additional interviews with fishermen, cataloging not only the locations but also specific years for which events could be recalled (Stevenson, et.al., 1999). Dr. Stevenson brought to the project an extensive history of herring spawning research, having conducted similar interview work in the 1984-1988 period, along with the first ever direct observation of bed sites with an ROV (Remotely Operated underwater Vehicle), and supporting hydroacoustic stock survey work (Stevenson, 1989, 1987, 1984). Changes in the state regulations governing the retention of spawn herring were also enacted in this year, with the adoption of a 20% tolerance for the retention of spawning condition fish. The earlier of the two events recorded may have possibly involved a body of fish that a purse seiner had previously set it's net around, but subsequently released after testing a sample of the fish and finding them to be ripe

The third year, 1999, saw the project expand to include Grand Manan Island, New Brunswick, an important spawning area believed to contribute larval herring later recruited into the Maine fishery (Coon, 1999), with fishermen Laurence Cook and Joseph Ingalls performing this monitoring. The coastal monitoring identified three spawning events between Cutler and West Quoddy Head and one event near Dark Harbour on the west side of Grand Manan. There was one report of herring eggs on lobster traps and an egg mat site in Narraguagus Bay near the town of Milbridge. The sampling of the site, fairly far up the estuary, identified the spawning event as smelt eggs, not herring eggs. The earliest site that was first positively sampled for herring eggs was on August 22. The stage development of the eggs indicated that they were most likely spawned between August 17 and 19. Eggs were present at the latest spawning event until October 3. The depth range of the three Maine sites was from 80 to 200 feet on substrate that was predominantly gravel. The Grand Manan site was in 40-70 feet of water on a rock and gravel substrate with kelp cover. Monitoring on Grand Manan involved the placement and regular observation of herring egg collectors, as no summer lobster trap fishery takes place in these Canadian waters. These collectors approximate the footprint of a lobster trap, but consist of only the bottom mesh, and thus cannot capture lobsters.



The project was expanded westward in its fourth year, 2000, to include an area from Monhegan Island, Maine to Grand Manan, New Brunswick. Initial conversations with fishermen in these areas were pessimistic about the chance of seeing any spawning activity. Many of the respondents in these informal interviews were curiously similar in identifying that spawning activity had ceased eight to twelve years previously in these areas, as well as confirming the general reduction of schools of inshore visiting summer and autumn fish. Canadian collectors showed no spawn in 2000. In U.S. waters, reports of five

events were investigated and sampled, resulting in two confirmed spawning events. One of these was the largest single event yet seen in the project, nearly a mile and three quarters miles in length. This event was on the same bottom as events in 1997 and 1999, giving us a valuable identification of a consistent and important spawning ground. Both events took place in the downeast area, with no activity to the westward of Cutler. After the 2000 project year the study area was reduced on the western edge not to include Monhegan. This reduction of the project area was based on fisherman's accounts of not seeing herring spawning in the area for a considerable time period.

A total of six events were reported and sampled in 2001, again centered on the Cutler region, and one event was sampled on the western shore of Grand Manan. No spawning events were reported west of Little Machias Bay. The first recorded spawning event of 2001 occurred in an area just south of West Quoddy Head. The event was reported August 29. Upon investigation and sampling of the event little spawn was found. In some areas sampled spawn was found, but little mat structure was present. The average water depth of the area where the spawning event occurred was over 115 feet. The second event occurred just south of the first event five days later, September 3. The second event was characterized by little mat structure. Areas with egg mat structure were predominantly found on regions of the site with gravel seafloors. The third event occurred just south of Bartlett Cove on Grand Manan. The Grand Manan event was reported and investigated on September 11. It occurred in an area with between 15 and 38 feet of water. It was the nearest to shore and most shallow event of the study year. Data on mat thickness and bottom structure/composition is not available. The fourth and fifth events occurred in an area off Moose Cove, seven miles north of Cutler. The two events were only separated by two days; the first was reported on September 23 and the second on the 25. Research partner Stillman Fitzhenry, felt, after examination of the eggs, that due to developmental differences the two events occurred independent of each other. Key to this decision was the presence of eyes within the eggs deposited during the event reported on September 23. There was a small degree of physical overlap in the two sites. The September 23 event was concentrated in water between 180 and 220 feet deep. It was the deepest event reported in the five years of the 1997-01 study. Egg mat was present on both gravel and shell bottoms with mat thickness ranging from .25 inches to .5 inches. The September 25 event occurred just south of the September 23 event. Egg mat structure averaging .25 inches was found in water ranging from 130 to 145 feet. It is not known if the eggs originated from the same body of fish as the September 23 event. The last event of the 2001 spawning season occurred October 21 just south of Cutler. The event occurred in an area where local fisherman/research partner Stillman Fitzhenry, "does not recall observing spawn within the last ten years." The site was in 80 to 100 feet of water. Substantial (.25 to .5 inches) mat was found to be present over a small portion of the site. During the 1983-88 study no spawning event was recorded after October 8. This was the second event in the five years of the current study to occur after October 17 and the fourth event to

occur after October 9. In the six years of the 1983-88 study only one event was recorded in the month of October. This compares to five events in the 1997-01 study.

The overall pattern of spawning activity observed the first five years of the project seems to represent a considerable decline when compared to the historical records, gathered both through the interviews associated with this project as well as through records of monitoring of spawning from 1983-1988 (Stevenson, 1989). The average of less than three spawning events per season from 1997-2000 (three in 1997, two in 1998, four in 1999, and only two in 2000) represents one-half the annual average number of events sampled by David Stevenson and David Libby working on the Maine Department of Marine Resources surveys from 1983 to 1988. The relative consistency of volume of spawning observed over the three years may indicate a sustained decrease in spawning activity, and not just reflect a single poor year, perhaps indicating a depressed coastal stock spawning biomass. However, Area 1A landings during these years continued to increase, averaging over 100 million pounds (Maine DMR, 2000). While this abundance would seem to refute the notion of a decreased stock, fish sightings in the close inshore area continued to be reported as reduced, and the fishing pressure, while remaining within management Area 1A, is commonly believed to have moved slightly farther offshore.

2002 PROJECT ACTIVITY

The study observation area in 2002 ran from Vinalhaven to the American/Canadian line. A total of four events were reported and three were sampled in the Cutler region. No spawning events were reported west of Little Machias Bay.

The first recorded spawning event of 2002 was reported August 24 (as compared with the first event in 2001 on August 27). This event was near Morton Ledge, covering an area that had spawn in 1999, and was reported as a regular area over the years during the fishermen interviews. This event took place in 90 to 110 feet of water, and covered the traps of a number of fishermen, involving up to 30 traps. This event was not sampled, but was reported by multiple independent lobstermen observers.

In the following week, spawn herring were reported to Stillman by two fishermen (one west of the Old Man Islands, and the other near Holmes Cove) on August 29. These fish had been caught in lobster traps, and were heavy with spawn but not running. No associated event was reported until September 7, almost two weeks later. Spawn herring were also reported at this time east of Morton Ledge in deep water, but no spawn was reported in that area at that time. This report of fish came in on September 1, and it is possible that these fish were associated with the August 24 event. The second sampled event (visited on September 7) was characterized by little mat structure (only up to .75", and scattered, with many samples of only .25"), and the possible presence of spawn herring on the bottom right in the area (as seen on the sonar). This event was near Bailey's Mistake, in deeper water than any of the other events so far in the six years of the study, with water depths varying from 194-229 feet. However, it was in a region just offshore of events recorded in both 2001 and 1997. While thinly scattered, this event was significant in size, compared to others. Large groups of small herring were seen near the surface on this trip as well. Areas with good egg mat structure were predominantly found on regions of the site with gravel seafloors.



Stillman Fitzhenry and Kristan Porter sampling a herring spawning event. September. 2003.

The third event, on September 14, was very large, occurring in the area south of Moose Cove, stretching down towards Bog Brook Cove. This event was also in deep water, with samples taken from 224 to 254 feet of water. This compares to the Bartlett Cove event on Grand Manan, which occurred at a similar time of the year, being reported and investigated on September 11, 2000. The Bartlett Cove event took place in an area with between 15 and 38 feet of water. It was the nearest to shore and most shallow event of that study year. The deepest event sampled prior to this event was the September 23, 2001 event, concentrated in water between 180 and 222 feet deep. Stillman believes that the change in spawning depth could be related to local sea surface temperature, which was higher in 2002 than in recent years. Stillman also noted that the herring seem to remain in the deeper water while preparing to spawn, then moving into shallower water, and that this year they just did not move in as much. However, herring of mixed ages have been observed and reported close to shore during the year, and brit and medium-sized herring were also observed on this sampling trip

The fourth event occurred in an area off Holmes Cove, closer to shore than the third event. This event was sampled fully a month after the third event, on October 15. This event had a strong and fairly continuous egg matt, and was more spatially concentrated than other events. Depth of water was much less than the first two sampled events, varying from 90 to 153 feet. The area where this event took place is an area where spawning has been observed in four of the six years of the study (overlapping, in some spots, exactly the same piece of bottom). Two events took place on this same bottom in 2001, only two days apart (September 23 and 25), and partially overlapping, and were discernable as separate spawning events by the developmental condition of the eggs (the presence of eyespots within the eggs).

For comparison, the last recorded event of the 2001 spawning season occurred October 21, with the fish spawning just south of Cutler. During the 1983-88 study no spawning event was recorded after October 8. This was the fifth event in the six years of the current study to occur after October 9. In the six years of the 1983-88 study only one event was recorded in the month of October. This compares to six events in the 1997-2002 study. Of these, only two recorded events have taken place after October 17th.

The region of coast between Cutler and West Quoddy Head appears to be particularly productive in the generation of herring spawn. In a single fifteen mile stretch of coastline between Cutler and West Quoddy Head spawning has been observed for five years of this six-year study. It is also a region that was productive during the 1983-88 study. However, in the 1983-88 study spawning was concentrated in an area between Englishman Bay and Little Machias Bay, just south of Cutler. In the 1997-2002 six-year study only two events were reported south of Cutler compared to 34 events south of Cutler in the 1983-88 six-year study.

Further direction for this research is undecided. The Island Institute has a continuing interest in questions of coastal herring abundance. Spawning area monitoring in a similar fashion could continue, perhaps expanding to include other possible inshore spawning areas, such as the White and Pumpkin Islands off Boothbay, where herring spawning has been documented in the past. Although these areas were outside the region for this year's observations, there was one report that some spawning may have taken place there in 2000. As hydroacoustic technology becomes available for smaller boats there is perhaps a role for this methodology in identifying inshore spawning aggregations, on a small-boat scale that would be feasible. The Island Institute is most open to projects that combine fisheries questions with the direct involvement of local fishermen and fishing communities in the research.

The spawning field studies will be followed up this summer with a Maine Seagrant supported study to interview older fishermen in the coastal area from Boothbay to Eastport, soliciting information about historical spawning sites. Considering the spawning site fidelity that has been shown in the six year field survey, it is hypothesized that other such areas existed, with spawning taking place year after year in very specific, memorable locations. In doing multiple

interviews, it is hoped that a number of areas will be identified, mapped, and given approximate dates of last spawning. In this fashion, investigation of the changes in herring spawning over the past few decades in the nearshore area will continue.

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