So many dead herring

Citizen scientists tackle a marine mystery in Southwest Nova Scotia

by Ted Leighton

It was Joan Comeau who first called Fisheries and Oceans Canada (DFO) to report dead herring. Comeau is a keen naturalist, and every day she walks the beach in front of her home in Brighton, N.S., on St. Mary's Bay. Suddenly, in early November 2016, there were freshly-dead herring along the high-tide line, and again the next day, and then every day, a few or many – always freshly dead, those from the day before seemingly washed away by the tide and replaced. This was not normal; she contacted the authorities.

Fishermen around the bay saw them too, and regarded them with professional concern. The dead herring were thin, underweight, and low in fat – too low even to use as lobster bait. Everyone wanted to know why the herring were dying, but the fishermen also posed a different question: why were there any herring at all in the bay at this time of year? Normally, there are no herring in the enclosed bays of Southwest Nova Scotia in fall or winter. But as dead herring were washing up on beaches, fishermen also saw massive schools of live herring in St. Mary's Bay, so dense that they hid the ocean floor from electronic depth sounders.

We are alarmed when wild animals around us die in large numbers. It seems both wrong and a bit threatening; perhaps whatever has killed the herring will harm us or our livelihoods or the places we live. We want quick answers to the news reporter's five big questions: Who has died? What is killing them? Where and when is this happening? And why did it happen at all?

It is not always so easy to answer these questions, however. Who will do all the work, and do it right now, setting aside their other responsibilities? Who will walk all the beaches in western Nova Scotia to find out where

Dead Atlantic herring along the high tide line of St. Mary's Bay on Dec. 5, 2016. (Joan Comeau photo)

Atlantic herring is an ecologically and economically important species in Maritime Canada, so there was public concern when people found great numbers of them washed up on beaches – but the phenomenon may actually have been the result of a normal mortality rate in an exceptionally high population. (Heather Grant – Ecology Action Centre photo)

the herring are dying? Who will count the dead and count the living? Who will assess the possible causes of death? Who will crunch the numbers to tell us if it matters or not, and to whom, and why?

The dead herring on the beaches in Southwest Nova Scotia were investigated with remarkable thoroughness by an unusual coalition of citizen groups and government agencies. Government scientists applied all available methods and tools to find out what might have killed the fish, and they searched through decades of records to give the event some context. But it was members of the general public, serving as volunteer scientists, who did the long hard work to determine where and when the die-off occurred, and to estimate the numbers of dead and living herring in the affected waters.

NETWORK

Joan Comeau and her husband Al are dedicated bird watchers, connected to other birders and naturalists through friendships, the Internet, and the Nova Scotia Bird Society. This network of people took on the task of surveying beaches for dead herring along the Bay of Fundy from Scots Bay to East Ferry, around the whole of St. Mary's Bay and south to Yarmouth, Pubnico, and Cape Sable Island. They did this regularly for 60 days, from early November 2016 to the first week in January 2017.

The Herring Science Council, a research organization funded by the fishing industry, carried out a systematic acoustic survey of St. Mary's Bay to estimate the number of live herring in those near-shore waters, and also measured the fat content of dead herring that were collected periodically. Students and staff of Université Sainte-Anne searched beaches and made observations of gull numbers, which increased during the event. DFO field staff also searched selected beaches regularly. As coordinator of the citizen science effort, I kept records of all observations and provided these to DFO on a regular basis.

What was learned? All the dead herring were similar in size and age: 18-26 cm (7-10 inches) long, and two or three years old – fish too young to spawn, and that would have schooled together. They were thin, low in fat, and low in weight for their length, whether assessed by experienced fishermen, the biologists' standard measure of "condition factor" (weight divided by length), or in fish processor laboratories. Sometimes only one or two dead herring would be found along a kilometre of beach, and sometimes thousands.

Dead herring were found at three locations, and nowhere else: around St. Mary's Bay from Sandy Cove to Saulnierville for the full 60 days of the event; on the western side of the Annapolis Basin from Bear River to Digby during the first two weeks in December; and among the bays and islands at the outflow of the Tusket River, from Wedgeport to Tusket and Lower West Pubnico, for most of December. The event ended abruptly at each location; dead herring no longer washed ashore, the vast numbers of gulls that had gathered (approximately 20,000 were present on St. Mary's Bay on Jan. 5, 2017) to feed on live and dead herring departed, and massive herring schools were no longer detected in near-shore waters.

ESTIMATED MORTALITY

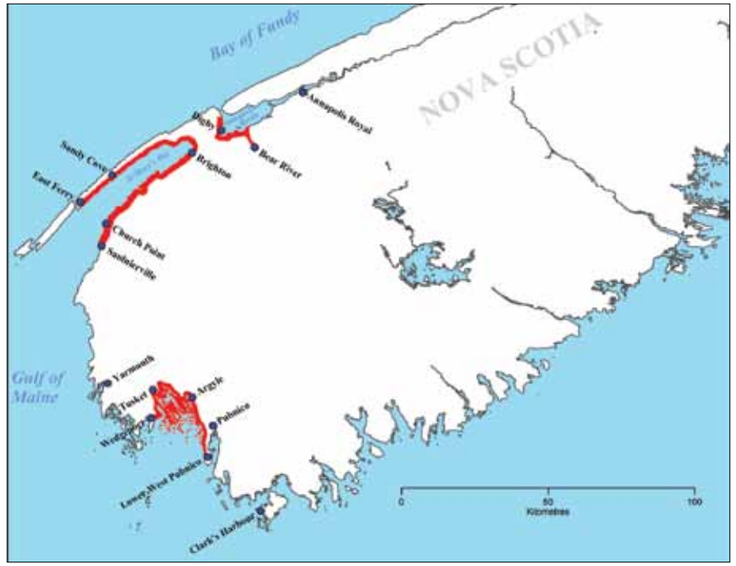
It was impossible to count the dead fish accurately, but we can attempt a crude estimate of the scale of mortality. How many dead herring would have to be present on a beach to be recognized by someone as unusual? My guess is an average of about one dead fish per linear metre or yard of high tide line. (Maybe the true number is closer to half of this, or maybe twice.) If this many herring were deposited with each tide and then washed away by the next tide, that would add up to 100,000 dead herring along the 100-km shoreline of St. Mary's Bay, delivered and washed away every 12 hours, or 200,000 each day. Over 60 days, that makes a total of 12 million dead herring. (Maybe half this number, or maybe double.) While 12 million is a staggering number, the acoustic survey in late December estimated that 200 million live herring were packed into St. Mary's Bay at the time. So the estimated 12 million fish dying over 60 days represents a mortality rate of only three percent of the bay's population per month.

What killed the herring? Government agencies did a massive amount of work to find out. DFO, the Canadian Food Inspection Agency, Environment and Climate Change Canada, and also the Canadian Wildlife Health Cooperative – each applied its particular expertise. They tested for the full range of infectious diseases; none was found. They tested the dead fish and the water for a wide range of pollutants and toxins; none was found. There was no smoking gun.

In the sea-wise villages of Southwest Nova Scotia, the sentiment on the street was that the death of the herring probably was due to "natural" causes, but that the massive schools concentrated in near-shore waters in fall and winter were highly unusual – a marked and perhaps worrisome departure from the usual seasonal behaviour of herring in the Gulf of Maine. With the scientific investigations completed and all the information on the table, this local sentiment remains the best-supported evaluation of the event, the one most consistent with everything we know.

STARVATION

It is surprizing how little we know about the natural history of Atlantic herring, a species so critically important to the economy and ecology of Maritime Canada. We do know that the annual mortality rate of herring aged two-three years is about 50 percent. So, of the 200 million herring in St. Mary's Bay in December 2016, only about 100 million will have survived to December 2017. Around 45 percent of this annual mortality is due to commercial harvesting, and another 25 percent or so is due to predators in the sea. About 30 percent of fish (2.5 percent each month) die each year from all other causes, the largest of which, in nature, is usually starvation.



Shoreline in Southwest Nova Scotia, marked in red, where dead herring were found during November and December 2016. Dead herring were not found along other shores in the region during this time. (Map courtesy of Lenny Shirose and the Canadian Wildlife Health Cooperative).

Like bears, herring don't eat during winter. Their food – tiny animals in the water that feed on the summer blooms of even tinier marine plants – runs out in the fall and does not grow again until April or May. They must survive winter on the fat and muscle they accumulate in summer. Most make it through winter, but many do not. So in St. Mary's Bay in November and December of 2016, we might expect two or three percent of the 200 million herring in the Bay to expire each month, which would produce about 5 million dead herring washing up on beaches each month, or 10 million over the two months of the apparent die-off. This is very close to my ballpark estimate of 12 million. And the dead herring were thin, with small muscles and little fat – typical of animals that have used up their energy reserves.

UNANSWERED QUESTION

In May 2017, a public meeting was held in Digby, facilitated by myself and another local science educator, to share information and invite discussion. About 50 people participated. The concerns and views expressed were diverse. While a few participants worried that some important cause of death had been overlooked, or kept secret by authorities, most seemed to accept the broad conclusion that the dead herring on beaches were the result of normal rates of mortality in herring schools that were present in unusually huge numbers in shallow enclosed bays.

But participants also expressed a wide range of concerns regarding the health of the ocean and the possibly broader implications of these unusual circumstances: pollution from forestry and agriculture, distant effects of tidal power installations, the warming of the seas, and reductions in herring numbers leading to new and unnatural behaviours and perhaps eventual extinction. With the critically important work of citizen scientists and the expertise of their professional colleagues, plausible responses to four of the news reporter's five big questions had been achieved. But the hardest question – why this happened – has yet to be answered.

(Ted Leighton is a science educator now retired from his position as director of the Canadian Wildlife Health Cooperative. He organized the citizen science effort to track the recent herring mortality event in Southwest Nova Scotia, which affected the beach near his home in Smith's Cove, Digby County.) ●