Scientists continue to research algal toxin levels in marine food web

By Peter Loewi

A study published in the upcoming May 2022 issue of the science journal *Harmful Algae* addresses toxins found in the Bering Sea food web during the unusually warm 2019. The paper estimates doses in marine mammals and could lay the groundwork for a model which could predict toxin levels in foods based on factors such as sea water temperature.

As water temperature rises due to climate change, the likelihood of harmful algal blooms, or HABs, increases. These algae produce a neurotoxin which poses potentially lethal consequences to all higher stages of the food web, including humans. According to the Department of Health and Social Services, there have been five deaths due to paralytic shellfish poisoning in Alaska since 1993, including most recently in 2020. There have been more than 100 non-fatal incidents reported in the same timeframe.

The lead author of the study, research biologist Dr. Kathi Lefebvre, spoke about her research to community members in a Strait Science presentation last week. Several times throughout the presentation, she reminded people that her research is not designed to answer whether something is safe to eat or not and encouraged submitting samples for proper testing.

All stages of the Bering Sea food web tested in 2019 contained trace amounts of saxitoxin, a potent neurotoxin caused by the microscopic algae *Alexandrium catenella.* When the water temperature is right, this alga divides and multiplies throughout the water column. The algae produce the toxin and poison the organisms which eat it, such as krill, worms or clams. In turn, these organisms can also poison what eats them, such as birds, whales and humans. According to Lefebvre's research, in 2019, clams had the highest concentration of the toxin, and in three places, in the Bering, Chukchi, and Beaufort Seas, had toxin levels above the safe regulatory limit. This toxin is also thought to be one of the causes of the 2019 seabird unusual mortality event, or UME.

In 2019, which was Alaska's hottest year on record, Lefebvre and her team took samples from as far south as Nunivak Island to Kaktovik in the north, to answer the question "How much toxin are we seeing?"

The seafood safety regulatory limit is 80 micrograms of saxitoxin —abbreviated STX— per 100 grams. This number was exceeded repeatedly throughout the research. In zooplankton, only one sample exceeded that limit, taken in Ledyard Bay.

Clams and worms were found to be more toxic than zooplankton, with three samples in unsafe ranges. One sample was taken east of King Island, one taken from Ledyard Bay and one was near Utqiagvik. None of the fish sampled exceeded the safe limit, even in the intestines, which were found to have higher concentrations. Two fish samples taken from between Shishmaref and Kivalina were found to have moderate levels of saxitoxins.

The researchers also collected samples of walrus and bowhead whale feces. Saxitoxins were detected in all 13 walrus feces taken north of Savoonga. Two of the 13 were in the moderate range, just shy of the regulatory limit. Seven of the nine bowhead samples taken north of Utqiagvik were found to have low levels.

The next step in the research was estimating how much toxin the larger marine mammals might eat in a day. Knowing how much each animal eats and how much toxin their foods might contain, researchers estimated that a walrus feeding on clams could ingest up to 21.5 micrograms of saxitoxin per kilogram of body weight, but on average, around five micrograms. Bowheads were estimated to be ingesting much less, between 0.05 and 0.15 micrograms, because krill contain much less toxin than clams. When asked about the implications, Lefebvre said that "we don't know what doses cause impacts on these marine mammals yet. That's what we're going to find out."

What is known, however, is that the larger the animal, the lower the dose by body weight needed for the same effect. A lethal dose of saxitoxin is much larger by body weight in mice than in humans, and so it would be even less needed to kill walruses or whales.

"Saxitoxins and paralytic shellfish toxins are present in Arctic food webs," Lefebvre said. "Walruses and bowhead whales are exposed to these toxins through their diet. We're going to keep doing this for multiple years to see if this is the standard thing." As toxin levels are directly related to the size and duration of the harmful algal blooms and as warmer waters are linked to larger blooms, there will be a lot to learn.

Some of what researchers still hope to learn includes: when or where the blooms will occur, how toxic the food will get, and when it is or isn't safe to eat shellfish.

Lefebvre accepted that this was unsatisfying but added, "we cannot answer that million-dollar-question as a research team. This is all under the same guidelines that the state gives for seafood safety." This applies to clams harvested from the guts of walruses, and because there are clams out there that contain over the regulatory limit of saxitoxins. Subsistence harvest communities will find it unsatisfying, but the DEC website on paralytic shellfish poisoning says little more than "don't eat shellfish harvested from untested beaches. Don't eat crab guts. Commercially sold shellfish and crab are routinely tested."

"I wish that I had better information or a good answer for that," Lefebvre said.

One thing in particular that Lefebvre hopes to do is determining which parts of marine mammals contain the toxins. Of the 13 walrus samples tested in 2019, all 13 had trace amounts detected in their feces, including two that were almost at the regulatory limit. However, the saxitoxins were not detected in any of the muscle or blubber samples. "This is the first set of data we have, we're going to continue to do this with you," she said.

In their ongoing studies, they are sampling toxicity of the feces, intestines, liver, kidney, heart, brain, muscle, and blubber. "That's the data we want to share with you when we get it," she said. "We're working on that now." She shared preliminary data comparing 2019 and 2021.

In 2021, they got 23 walrus fecal samples, and only 61 percent, compared to 2019's 100 percent, of the samples had detectable toxins. She also shared some preliminary data taken on clams, showing several over-the-limit samples taken in 2020, but much fewer in 2021. These types of studies will lead to a better understanding of the environmental conditions that cause harmful algal blooms and increases in toxins. This data can be used to develop a model to predict when and where wildlife will be impacted. A full research cruise for 2022 is already planned to collect more samples.

Many community members who called into the talk asked about other species, such as halibut or sea peaches. Lefebvre said that there was no plan for regular samples, but any samples sent in can be tested. Any samples should be frozen as soon as possible after collection, and include the date, location and species.

Her specialty being marine mammals, whales and pinnipeds were of the most interest, but fish samples could be tested, too. At another request from community members, Lefebvre will start collecting walrus mammary glands for sampling, as some toxins are known to travel from mother to pup.

Speaking to the Native villages who make up an integral part of the team effort, Lefebvre said "Our promise to you is that we will be sharing this data with you. We want to share this as we get it and work together to see what is happening in the Arctic."