Paralytic Shellfish Poisoning (PSP) -2017 Report from Alaska

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The Aleutian Pribilof Islands Association (APIA) has been working for over a decade to understand the risks from paralytic shellfish poisoning (PSP), both to people and the ecosystem. Our work at APIA on harmful algal blooms began in 2005 with 20 monitoring stations from Ketchikan all along the Gulf of Alaska coast, all of it, all the way to Russian where we also trained technicians on the Commander Islands to collect monthly samples and test for PSP. The initial monthly sampling effort lasted just over a year and established a necessary PSP baseline for future PSP work in Alaska.

What We Have Learned

Over the years we have learned that PSP is found all along the Gulf of Alaska coast and into the Bering Sea and the Arctic Ocean. The APIA PSP research effort resulted in uncovering the risk of eating the hepatopancreas (guts) from crab and shrimp from our research in Haines, Alaska (*Tiayasanka Harbor*, Lutak Inlet, Dungeness crab PSP results at 1,055 µg/100g when the FDA limit for PSP in bivalves is 80 µg/100g). We also secured the unfortunate honor of recording the highest PSP level ever measured in Alaska, blue mussels from Viking Cove, Haines had PSP at 21,600 µg/100g. At Pt. Louisa, Juneau, Alaska, we had a baseline from 2006 with low PSP levels for several years. The highest levels we recorded for Pt. Louisa in summer 2014 when the PSP levels increased to 151 µg/100g and in summer 2015 to 148 µg/100g. That's the same beach where a woman consumed cockles in summer 2010 and subsequently died from PSP.

The data sets for some of our monitoring stations reveal an obvious shift in persistence of PSP and especially in the Aleutian Islands and Pribilof Islands. For example, the Qagan Tayagungin Tribe of Sand Point, Alaska data suggests two shifts of increasing PSP, in 2010 and 2014 (see more). After the May, 2014 jump in PSP in Sand Point, the levels have not dropped below the FDA limit for PSP in bivalves (80 µg/100g).

Akutan Forecast Station?

We have seen that high levels of PSP in Akutan seem to forecast region-wide (Aleutian Islands) PSP events. In July 2010 the Akutan PSP levels were 390 µg/100g and in 2015 the levels reached 221 µg/100g, both were years of region-wide PSP events. These region-wide PSP events occur during years we measured high ocean temperatures (collected at Akutan, King Cove and Unalaska). Usually Adak, Alaska (further out the Aleutian Islands' chain) has low PSP levels, but the PSP levels reached 94.3 µg/100g on 6/18/15, the highest level ever recorded for Adak. Also in 2015, Pauloff Harbor, Sanak Island butter clam collected 5/16/15 had a PSP level of 336 µg/100g and Unalaska mussels on 6/12/15 had PSP levels of 784 µg/100g. The 2017 Akutan PSP levels were low, only reaching 40.5 µg/100g in August.

Northern Shift of PSP Events

The northern shift of high PSP levels is of great concern. The monitoring station of St. George in the Pribilof Islands of the Bering Sea indicated PSP was below 80 µg/100g until 2014 when the levels in September 2014 were at 240 µg/100g, then in July 2016 jumped to 1,590 µg/100g. The levels measured in August 2017 were 575 µg/100g.

Fall, Winter, Spring PSP Events and Food Safety Concerns

King Cove, Alaska is very important for its valuable subsistence butter clam resource in the Lagoon, but PSP events beginning in 2008 have increased the risk of subsistence harvests. In July 2008 the PSP levels in butter clams was 1084 µg/100g, in July 2010 it was 641 µg/100g, June 2016 it was 481 µg/100g, but some of the PSP events also occurred during the colder months, the months with an 'r' in them.

King Cove PSP events during fall, winter and spring

Date	PSP level
3/27/09	152 µg/100g
4/30/10	106 µg/100g
12/28/10	138 µg/100g
12/9/11	99 µg/100g
10/22/13	108 µg/100g
4/6/14	98.1 µg/100g
4/16/15	89 µg/100g
11/16/16	88.9 µg/100g
2/1/17	93.6 µg/100g
10/16/17	99.2 µg/100g

Monitoring beaches for PSP leads to some understanding of the dynamics of PSP levels, but in no way does it offer a mechanism for food safety. The APIA project is not a food safety program; we would be foolish to make harvest recommendations based on these data. However, there is a way, a way the state of Alaska has approved, harvest-hold-test. That is simply to hold your harvested clams or other bivalves (out of the ocean of course) until the test results come back from the lab. If the PSP levels are high, discard the clams. This procedure is the only way to protect people from PSP who harvest bivalves from Alaska beaches for personnel use (see attachment for details). Bivalves found in your stores are tested for PSP and are considered safe to eat.

PSP and the Ecosystem

Reports of dead and dying seabirds, sand lance (a forage fish) and large fish have led us to focus on the ecological effects of PSP. Windrows of tons of dead sand lance across from Sand Point on Unga Island, and near False Pass, and the sick and dying birds (gulls and eagles were noted) feeding on the sand lance resulted in our asking fishers, elders and others in the Aleutian Island communities about these events and about their thoughts. The survey reveals a link with the dead sand lance and sick or dead birds. A dead gull recovered from False Pass in July 2015 had elevated PSP levels (13.4 µg/100g), but without controlled experimenting and testing we cannot determine if the PSP was the cause of death. The False Pass technician who collected the gull described that during the 2015 event many gulls and eagles lacked coordination, had difficulties in flying and some died.

The Hypotheses

The Steller sea lion population is depressed in much of the Aleutian Islands, and as low as 95% below historic levels. Judging from the data we have gathered over more than a decade in the Aleutian Islands and the local knowledge shared with us, we see a strong link to PSP events and the 95% decline in the endangered sea lion population and seabird die offs in the Gulf of Alaska and the Bering Sea.

Some species are at risk from direct poisoning from PSP by consuming the organism that makes the PSTs (paralytic shellfish toxins), *Alexandrium sp.*, or feeding on the toxic organisms further up the food web. For example, copepods and euphausiids feed on *Alexandrium sp.,* become toxic with the PST and pass these toxins up the food web to other forage species such as the common forage fish in the region, sand lance. The toxins can incapacitate the forage species at which time they are easy prey for top predators such as sea lions. We have measured PSP from samples collected from dead sea lions' stomachs in the Aleutian Islands.

A delayed response occurs after the forage species (copepods, euphausiids, sand lance) die and are thus removed from the food web, leaving other marine predators without food. Accordingly, this can explain why, after several months, we see starving marine life, especially sea birds washing up on beaches, most starved to death. The birds didn't die from PSP toxicity, they died because the PSTs disrupted the ecosystem. Months after the massive 2015 harmful algal bloom in the Gulf of Alaska (GOA), thousands of murres, starving or starved to death, washed up on GOA beaches. And, months after the record 2016 PSP levels in the Pribilof Islands (St. George PSP levels 1,590 µg/100g), starving and starved puffins washed up on the islands' beaches. The PST didn't kill the puffins, as erroneously reported in some news articles, they died from starvation because the PST disrupted the ecosystem.

We recorded high levels of PSP in sand lance collected near Homer, Cook Inlet, Alaska. Live sand lance collected in Taiysanka Harbor, Haines, Alaska in July 2014 had whole body PSP level of 34.8 µg/100g (composite sample). Dead sand lance with the highest PSP levels we measured were from our most northerly monitoring site near Deering, Norton Sound, Alaska. The Deering sand lance had PSP levels of 758 µg/100g (whole body). Samples of sand lance recovered from a 2017 Deering, Alaska king salmon's stomach are in the ADEC-EHL queue with HPLC results expected soon.

Other species at risk in the Gulf of Alaska and Bering Sea include Yukon Rivers king salmon, walrus, fur seals and sea otters; they all could feed on PSP-contaminated prey. Hundreds of sea otters tested for PSP had detectable levels of the toxin. A dead sea otter collected in southeast Alaska on 8/7/14 had a PSP level of 541 µg/100g in pleural fluid (around the lungs) and another had domoic acid (another harmful algal bloom toxin found in Alaska) of 595 PPM in its urine (FDA legal limit for domoic acid is 20 PPM).

During the 2015 Gulf of Alaska harmful algal bloom (HAB) event, several monitoring stations, reported from plankton tows, had high concentrations of the dinoflagellate *Alexandrium sp*. (responsible for PSP) and *Pseudo-nitzschia*, the marine planktonic diatom genus containing some species capable of producing the neurotoxin domoic acid. We did not detect any domoic acid in the biological samples sent to the ADEC-EHL.

Caution Advised

Shellfish harvesters should be advised that PSP is a serious health risk when consuming personally harvested shellfish. Crabs feeding on toxic mussels, clams or fish (sand lance) can accumulate PSP toxin in their digestive system, so I recommend that before cooking, remove the back shell of the crab and clean out and discard all the dark soft tissues that comprise the digestive system and crab butter. The same may be true for shrimp; clean them before cooking. Bivalves (clams, mussels, oysters, scallops) sold at wholesale and retail markets require PSP testing and are considered safe for human consumption, but crabs or shrimp are not regularly tested for PSP. Forage fish, such as sand lance (AKA needle fish, candle fish, sand eels) can become toxic with PSP too. The attached flyer explains the significance. I recommend not eating dead or sick looking forage fish found on Alaska beaches and report these events to me.

Partners

APIA is working with the University of Alaska SeaGrant Program, NOAA (National Oceanic and Atmospheric Association), and others, and funded by the North Pacific Research Board, to develop a field test for PSP. A poster will be presented at the January 2018 Alaska Marine Science Symposium that describes our progress on that endeavor and the associated studies (poster attached). Pay special attention to the information we have on reducing the risk of PSP toxicity by carefully selecting the safer parts of butter clams and discarding the siphon and siphon tip. Of course, the only way to insure a safe meal of subsistence clams is to test them before you eat them. Really, that's the only way!

The samples for this project are all analyzed by the Alaska Department of Environmental Conservation Environmental Health Laboratory (ADEC-EHL) using approved analytical methods (HPLC or mouse bioassay), and/or the *NOAA, National Ocean Service* Beaufort Laboratory, Southeast Fisheries Science Center, Beaufort, NC. Over 95% of our analyses have been analyzed using HPLC (high performance lipid chromatography).

The samples from Sand Point were collected by the Qagan Tayagungin Tribe and analyzed at ADEC-EHL. The King Cove samples were collected by the Environmental Coordinator, Agdaagux Tribe of King Cove, Alaska. In Adak, USFWS collects PSP samples, in Unalaska the SeaGrant Agent collects and ships samples to the lab and in Akutan, Atka, False Pass, Nelson Lagoon, and St. George the APIA Village Protection Safety Officers make the collections. In Chignik Lagoon the Environmental Coordinator collects the samples and in Deering, Norton Sound the samples are collected by another friend. APIA makes the collections from Amchitka, Nikolski and Sanak Island in the Aleutian Islands.

APIA will continue its harmful algal bloom studies, and continue to work to understand risks of PSTs to people and the marine ecosystem.

References

1. Qagan Tayagungin Tribe and analyzed at ADEC-EHL https://www.qttribe.org/index.asp?Type=B_BASIC&SEC=%7B12BC3FE9-E8ED-4E09-B3F6-6D6254E121B1%7D