2022 Alaska Summary Report of Regional Harmful Algal Bloom Activities

Compiled by the Alaska Harmful Algal Bloom Network
July 2023

Opik Ahkinga

AOOS
Alaska Ocean Observing System

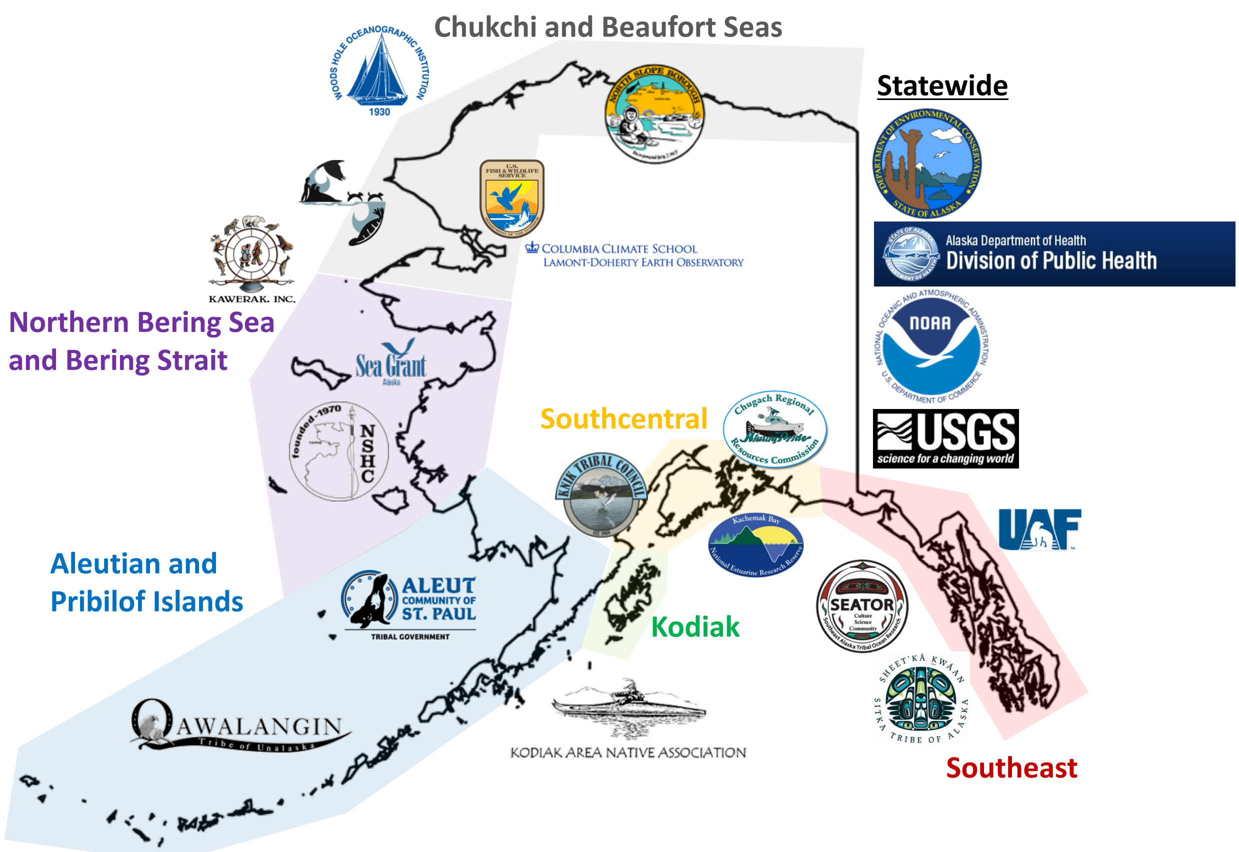
Alaska HAB Network

Alaska
Harmful Algal Bloom Network

Background

The Alaska Harmful Algal Bloom Network (AHAB) was formed in 2017 to provide a statewide approach to HAB awareness, research, monitoring, and response in Alaska. AHAB is made up of researchers, tribal environmental staff, outreach specialists, community contacts, and resource managers, and coordinates a diverse group of coastal ocean users to address human and wildlife health risks from toxic algal blooms. For more information about AHAB and HABs in Alaska please visit: ahab.aoos.org.

This document is a compilation of HAB monitoring efforts and results by region for 2022. Regional sections were completed by regional leads. AHAB intends to publish an annual summary of this nature every year. The focus of this report is on areas and organizations that have established, or are currently establishing, monitoring programs for HAB forming phytoplankton or the toxins from HABs in water samples or organisms like shellfish, fish, seabirds, and marine mammals.



The report is broken down into regions, as represented by the map above. Logos from the organizations that are leading the HAB sampling are positioned in the general area where the sampling is taking place.

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COVER PHOTO: Sample taken from a phytoplankton tow under the ice at Little Diomede. Photo credit: Opik Ahkinga

Southeast Alaska

SITKA TRIBE OF ALASKA ENVIRONMENTAL RESEARCH LAB

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HAB Role in Alaska

The Sitka Tribe of Alaska (STA) operates the Sitka Tribe of Alaska Environmental Research Lab (STAERL). STAERL analyzes subsistence, community, and research shellfish samples for paralytic shellfish toxins (PSTs), domoic acid, and okadaic acid. STAERL prioritizes subsistence shellfish samples submitted by tribes in coastal Alaska.

Summary of Activities undertaken in 2022

In 2022, STAERL analyzed 282 shellfish samples for paralytic shellfish toxins, 63 samples for domoic acid, and 201 samples for okadaic acid. The four primary species tested for each toxin are blue mussels, cockles, littleneck clams, and butter clams. In addition to these four species, STAERL also tested pink scallops, rock scallops, eastern softshell clams, and arctic surf clams for PSTs. PST samples were analyzed from 16 communities throughout coastal Alaska. The four primary species were analyzed for domoic acid in 15 communities throughout the Gulf of Alaska, and the four primary species and Pacific oysters were analyzed for okadaic acid in 16 communities throughout the Gulf of Alaska.

Summary of Key Findings

STAERL analyzed 79 samples that were at or above the regulatory limit (80 µg of toxins per 100 grams of shellfish tissue) for PSTs; 34 of these samples were butter clams. STAERL analyzed one blue mussel sample from Juneau that exceeded the regulatory limit for okadaic acid (160 µg of toxins per 100 grams of shellfish tissue). There were no samples that exceeded the regulatory limit for domoic acid (20 µg of toxins per 100 grams of shellfish tissue).

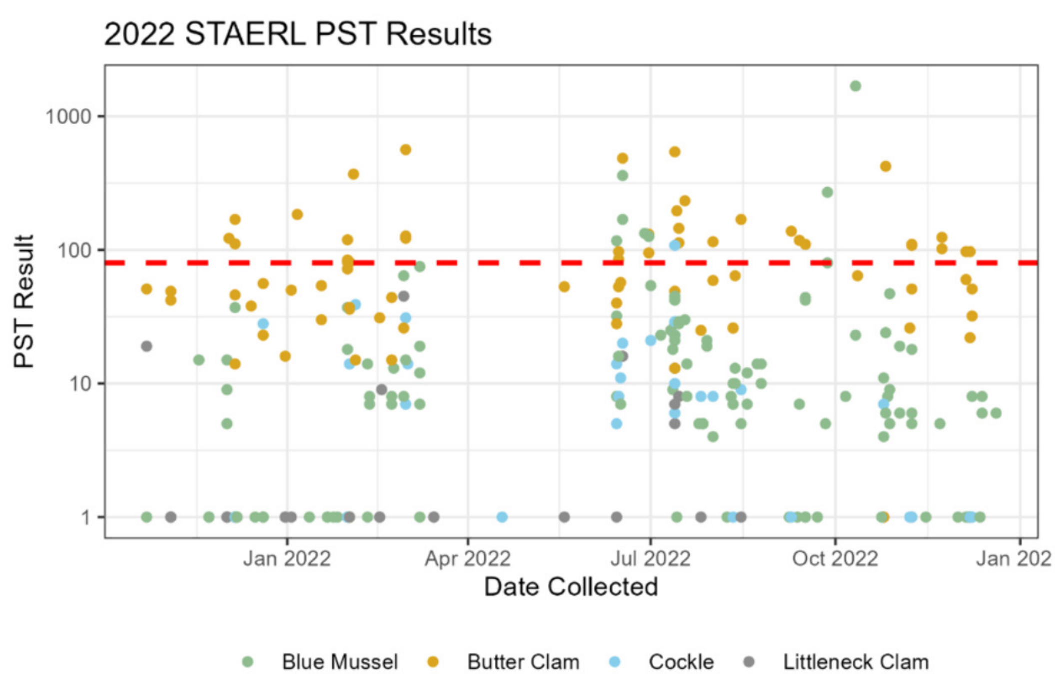

FIGURE 1. Paralytic Shellfish Toxin (PST) results for the four primary subsistence shellfish species analyzed by STAERL in 2022. The red line is the regulatory limit for PSTs in shellfish (80 µg of toxins per 100 grams of shellfish tissue).

SOUTHEAST ALASKA TRIBAL OCEAN RESEARCH

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HAB Role in Alaska

The Southeast Alaska Tribal Ocean Research Consortium (SEATOR) is a nonprofit organization that serves tribes in Southeast Alaska. SEATOR is the primary coordinator for tribes in Southeast Alaska who collect HAB baseline data and submit subsistence shellfish to the Sitka Tribe of Alaska Environmental Research Lab (STAERL). SEATOR partner tribes also collect environmental parameters on subsistence beaches throughout the year including surface seawater temperature, and salinity. SEATOR also hosts sample identification and collection trainings. In September 2022, SEATOR hosted a region wide training in Juneau at the Southeast Environmental Conference.

SEATOR Partner Tribes include: Craig Tribal Association, Chilkoot Indian Association, Hoonah Indian Association, Hydaburg Cooperative Association, Central Council Tlingit and Haida Indian Tribes of Alaska, Organized Village of Kasaan, Organized Village of Kake, Klawock Cooperative Association, Ketchikan Indian Community, Kodiak Area Native Association, Metlakatla Indian Community, Petersburg Indian Association, Sitka Tribe of Alaska, Skagway Traditional Council, Wrangell Cooperative Association, and Yakutat Tlingit Tribe.

Summary of Activities undertaken in 2022

In 2022, six SEATOR partners collected 174 phytoplankton samples from 12 locations. SEATOR partners also submitted 258 shellfish samples from five species to STAERL for paralytic shellfish toxin (PST) analysis. A portion of these samples were also tested for domoic acid and okadaic acid.

Summary of Key Findings

In 2022, *Alexandrium* was present in thirteen phytoplankton samples between April and October, *Dinophysis* was present in 17 phytoplankton samples between May and December, and *Pseudo-nitzschia* was present in 71 phytoplankton samples and occurred in all months. Surface seawater temperatures were recorded to be above 7.5°C 134 times in 2022. Based on sampling efforts, surface seawater temperatures above 7.5°C occurred in the region between April and December.

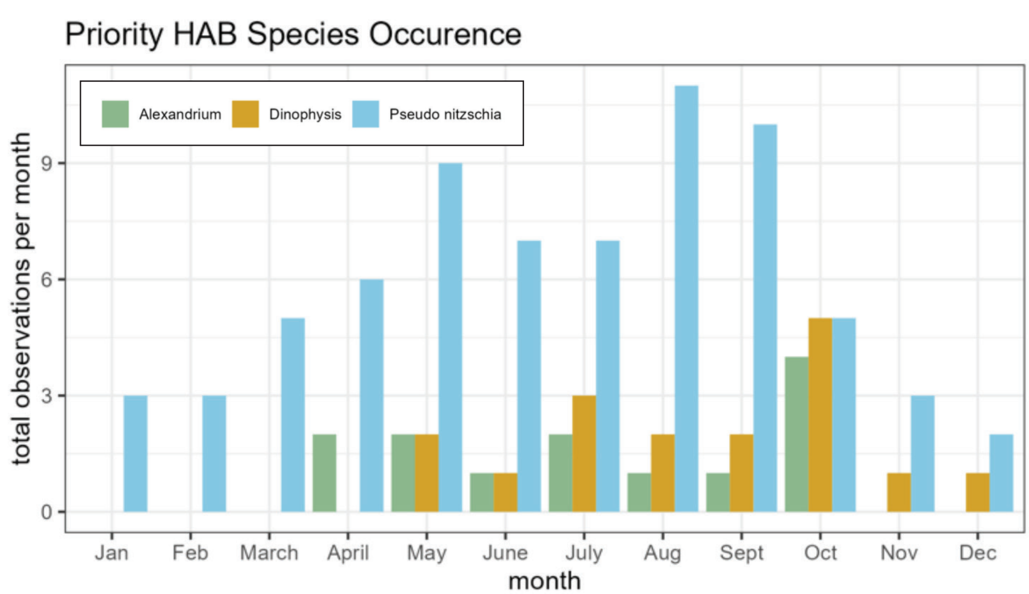

FIGURE 2. **Monthly observations for each priority Harmful Algal Bloom (HAB) species of concern in 2022.** ***Alexandrium*** **was observed in April through October,** ***Dinophysis*** **was observed May through December, and** ***Pseudo-nitzschia*** **was observed in all months.**

NOAA ALASKA FISHERIES SCIENCE CENTER

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HAB role in Alaska

We are continuing a long-term monitoring project (started at UAF) examining environmental conditions, phytoplankton community composition (including HAB species), and PSP toxins in water and oyster tissue samples at an oyster farm in Juneau, AK. We may also expand to other research projects in the future (e.g., DA toxins, eDNA).

Summary of activities undertaken in 2022

Water column and oyster tissue sampling occurred weekly from March to October, and monthly from November to February, at a local oyster farm in Juneau, AK. We measured water column parameters (temperature, salinity, nutrient concentrations, and chlorophyll levels) at 1 meter and 5 meters, environmental conditions (season, air temperature, weather, tide height, and wind speed and direction), PSP toxin levels in oyster tissue and in the water column at 1 and 5 meters, lipid content and fatty acid composition in oyster tissue, and phytoplankton community composition via a plankton net tow and phytoplankton counts in water samples from 1 and 5 meters. We took a total of 29 samples in 2022. Monitoring took place at one oyster farm in Bridget Cove, north of Juneau, AK; however, we hope to expand monitoring to other aquaculture sites in SE AK in some capacity in the future.

Summary of key findings/highlights from 2022

We found that environmental variation in Bridget Cove followed seasonal patterns. Air and water temperatures were lower in winter and higher in summer. Salinity followed the opposite pattern: it was lower in the summer due to high rainfall and glacial runoff, and higher in the winter when many of the freshwater input sources are frozen. Chlorophyll-a levels peaked in the spring, were slightly lower in the summer and fall, and quite low in the winter. Nutrient levels were highest in the winter and lowest in the summer.

Phytoplankton biomass and community composition also varied seasonally. The first phytoplankton bloom occurred in the late spring, followed by an even larger summer bloom and a smaller fall bloom. The spring and summer blooms tended to be dominated by diatoms, while the fall blooms were more likely to be dominated by dinoflagellates. In 2022, the five most abundant phytoplankton genera were *Chaetoceros, Pseudo-nitzschia, Skeletonema, Thalassionema*, and *Thalassiosira*. In terms of HAB genera, we observed large *Pseudo-nitzschia* blooms in the summer and fall. A *Pseudo-nitzschia* bloom in a July 2022 sample was identified as *Pseudo-nitzschia* pungens, a DA-producing species, via a scanning electron microscope. *Alexandrium* and *Dinophysis* occurred less frequently and only in small numbers.

PSP toxins were measured using SeaTox ELISA kits. PSP toxins were highest in oyster tissue in the spring, and then declined in the summer before beginning to increase again in the fall; however, no 2022 samples exceeded the DEC threshold of 80 µg/100 g. PSP toxins in the water column were fairly low and more variable. They were also highest in the spring, but lowest in the fall.

Links

- https://www.fisheries.noaa.gov/about/alaska-fisheries-science-center (NOAA AFSC website)
- https://afscmariculture.github.io/oyster_report/ (GitHub website with summary of the project and findings)

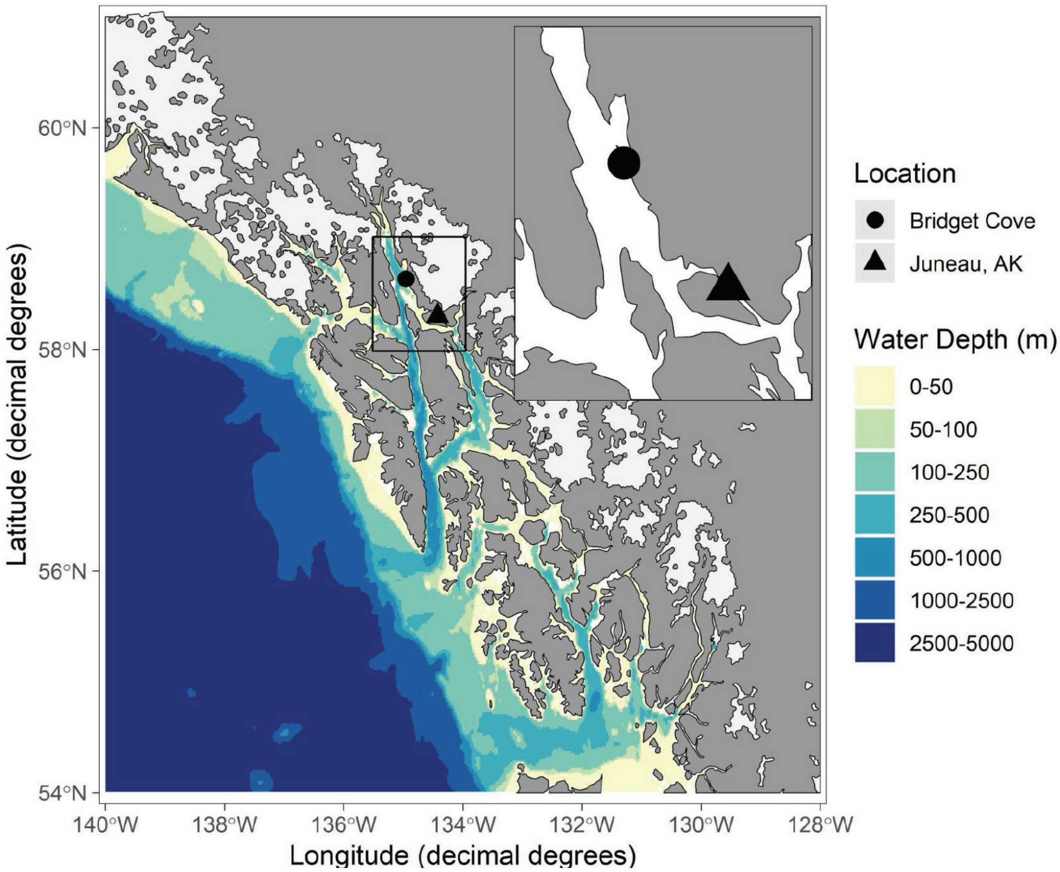

FIGURE 3. Map of southeast Alaska, displaying water depth (color scale) and glaciers (in white). The locations of Juneau, Alaska and the sampling location in Bridget Cove, north of Juneau, are displayed and magnified in the inset. Note, the inset does not include water depth or glaciers.

FIGURE 4. The oyster farm in Bridget Cove in Juneau, AK.

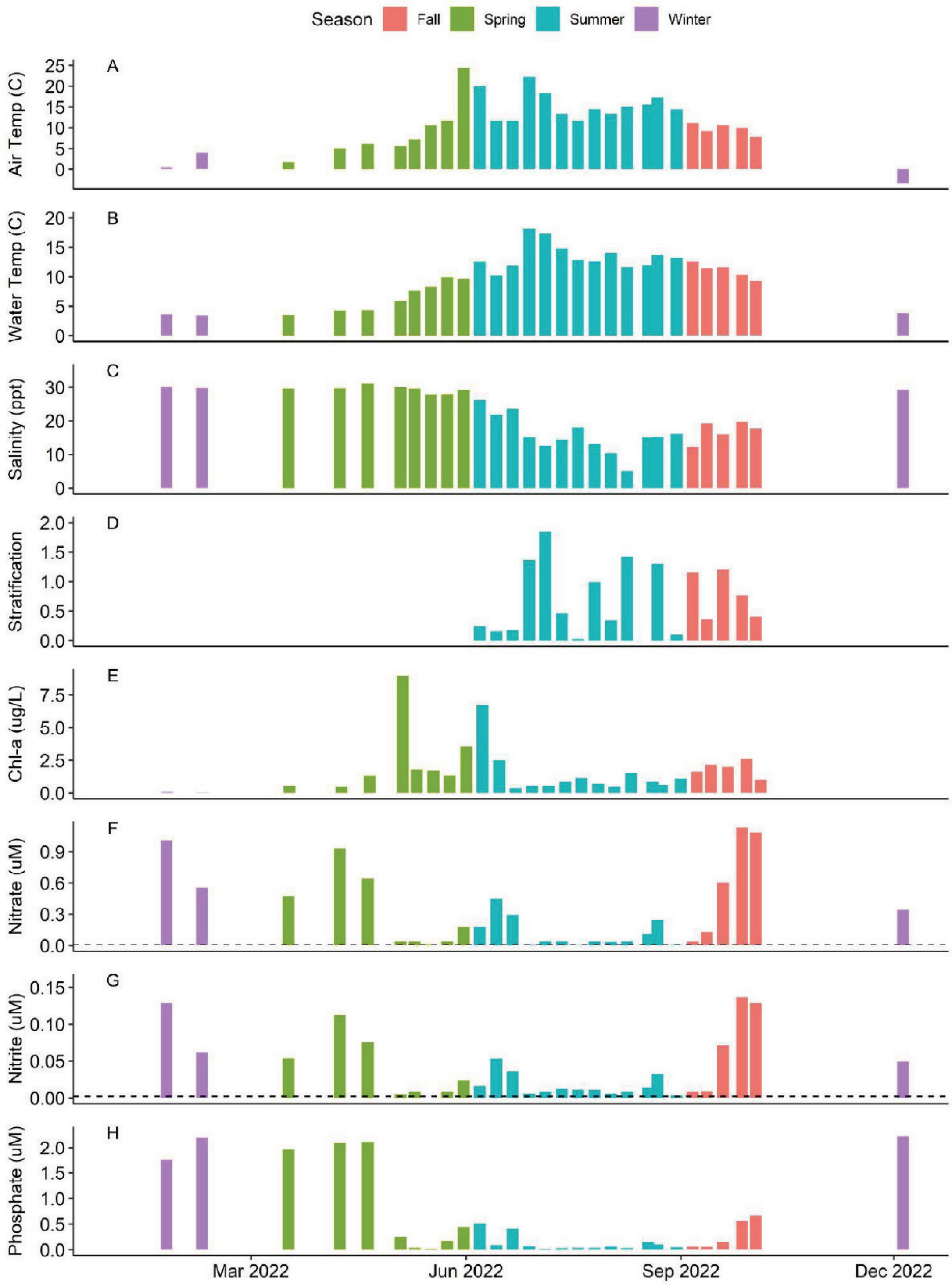

FIGURE 5. Environmental conditions: air temperature in ˚C (A), water temperature in ˚C (B), salinity in ppt (C), stratification index (D), chlorophyll-a levels in µg/L (E), nitrate levels in µM (F), nitrite levels in µM (G), and phosphate levels in µM (H), measured in Bridget Cove at a 1-meter depth in 2022. For nitrate (F) and nitrite (G), data below detection limits were imputed and the detection limit is displayed as a dashed line.

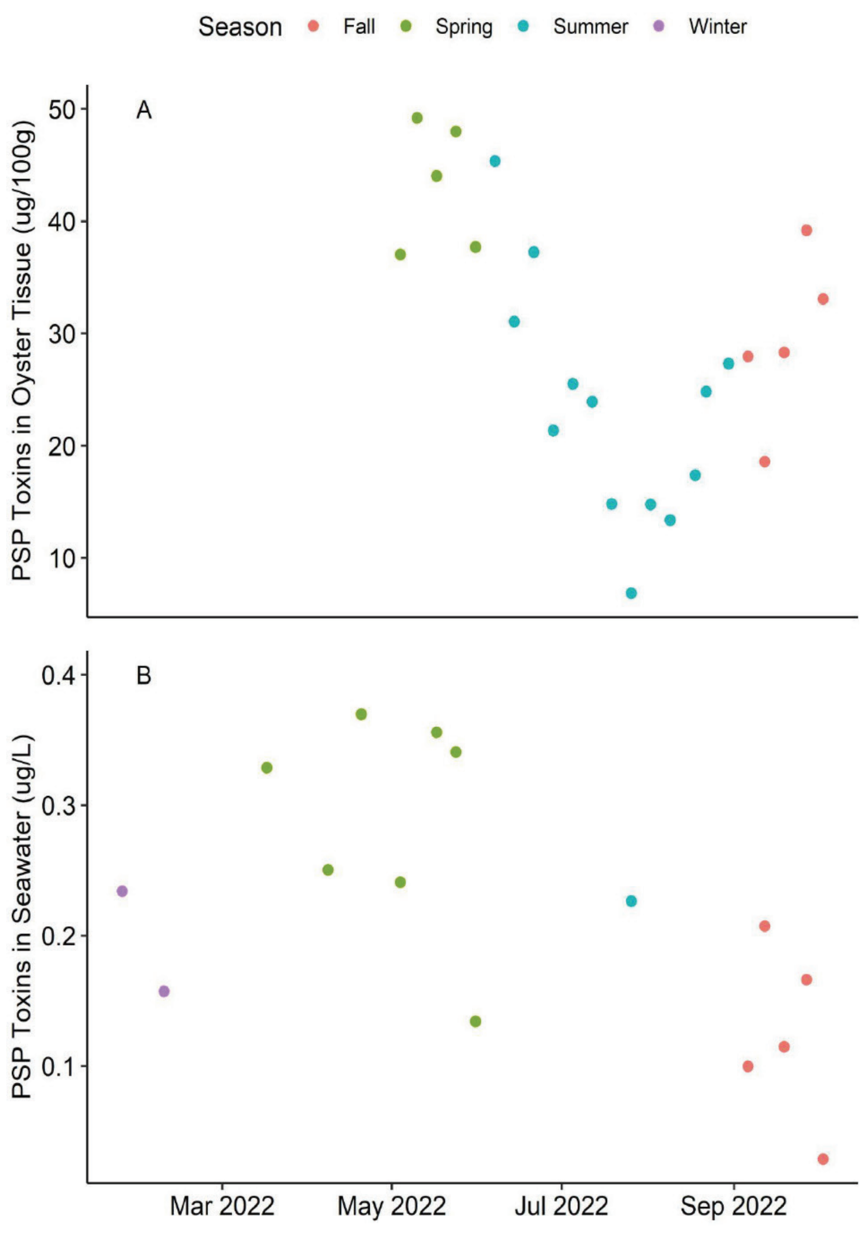

FIGURE 6. PSP toxin levels (µg/100g) in oyster tissue samples (A) and PSP toxin levels (µg/L) in the water column at a 1-meter depth in Bridget Cove in 2022 (B). PSP toxins were measured using a SeaTox ELISA kit.

Southcentral Alaska

KACHEMAK BAY NATIONAL ESTUARINE RESEARCH RESERVE

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HAB role in Alaska

The main goal of the KBNERR HAB monitoring program is to look for groups of phytoplankton that are known to produce toxins that can result in shellfish poisoning. KBNERR staff receive samples from community monitors from around the Kachemak Bay area.

Summary of activities undertaken in 2022

Samples were received from 23 locations around Kachemak Bay. 129 phytoplankton samples were collected in 2022.

Summary of key findings/highlights from 2022

Although species of concern were present in Kachemak Bay in 2022, none of these species were found at bloom levels. The most prevalent species of concern was *Pseudo-nitzschia*, although it has decreased in the number of samples that it was present in from 60% in 2021 to 53% in 2022. *Alexandrium* and *Dinophysis* were present in more samples in 2022, increasing from 5% to 9%, and from 35% to 39%, respectively.

For more information, see the KBNERR website: https://accs.uaa.alaska.edu/kbnerr/community-monitoring/

FIGURE 7. Map of KBNERR 2022 phytoplankton collection sites around Kachemak Bay.

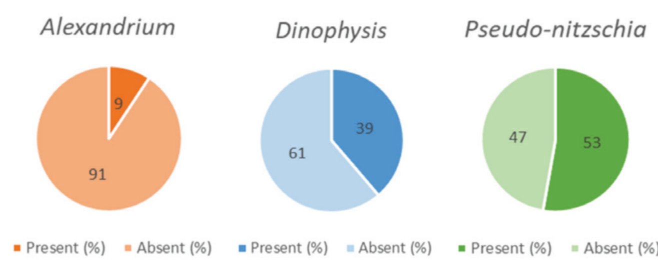

FIGURE 8. Percent of samples in which *Alexandrium*, *Dinophysis,* and *Pseudo-nitzschia* were present.

TABLE 1. Months in which *Alexandrium*, *Dinophysis,* and *Pseudo-nitzschia* were observed (in green).

	2022 Observations of Species of Concern																																															
	Jan				Feb				March				April				May				June				July				Aug				Sept				Oct				Nov				Dec			
Alexandrium																			■	■		■	■	■	■				■		■																	
Dinophysis															■				■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■			■	■						
Pseudo-nitzschia										■		■		■			■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■		■	■	■	■			■		■					

KNIK TRIBE

Bruce Wright (bwright@kniktribe.org)

HAB role in Alaska

This project, "Climate Change Planning; Assessment of Paralytic Shellfish Toxins in Alaska Salmon," investigated paralytic shellfish toxins (PSTs) to shellfish and commercially important predatory fishes in southcentral Alaska marine ecosystems.

Objectives

1) Quantify PST concentrations in mussels at key locations to determine the timing, duration, and severity of the 2022 summer *Alexandrium* bloom.
2) Quantify PST levels from all 5 Alaska salmon species.
3) Provide information about toxicity to the ADEC (Environmental Health Lab) and ADHSS Division of Public Health (Epidemiology).
4) Prepare and share outreach materials that present and synthesize the data to community and Tribal members.

Results

The Knik Tribe paralytic shellfish poisoning (PSP) project sampling began at some locations in early spring 2022 and expanded to additional communities in early summer 2022. Sampling continued into December 2022.

TABLE 2. List of species tested in 2022

Mussels
Chum salmon (Liver)
Coho salmon (Liver)
Razor clams
Butter clams
Sand lance (from Chinook Salmon stomachs)
Chinook salmon (Liver, Head, Digestive Materials)
Flounder (Liver)
Pollock (Liver)
Sockeye salmon (Liver)
Halibut (Liver)
Pacific cod (Liver)
Sculpin (Liver)
Oysters
Black rockfish (Liver)

Chignik Lagoon

In 2022 Chignik Lagoon's highest levels of PSTs were reported in razor clams collected on 6/13/22 (520 ug/100g) and 6/16/22 (620 ug/100g). None of the razor clams tested were below the safe consumption level set by the FDA. Butter clams collected from the same location during the same time had a PST level of 111 ug/100g.

Delta River

The 2022 Delta River chum salmon had no detectable levels of toxin in their livers in any of the samples collected 12/22/2022.

Homer

Samples from Homer and Kachemak Bay consisted of shellfish, salmon livers, and other fish livers. The highest reported level of toxin was from a pollock liver from Kachemak Bay collected on 10/31/2022 testing at 50.9 ug/100g.

Juneau

The 2022 Juneau PSP data indicates low toxin levels or non-detectable toxin levels in all samples. The samples tested in this location consisted of oysters, mussels, and Chinook salmon livers.

King Cove

In King Cove, blue mussels, Pacific cod liver, and black rockfish livers were tested for toxins. King Cove mussel data indicates mid-June 2022 for the onset of the *Alexandrium* bloom, with levels dropping below the FDA limit of 80 ug/100g by early July 2022. Since the only samples collected were in May, June, and July, we do not know the full extent of the bloom. The Pacific cod and black rockfish liver samples reported non-detectable toxin levels.

TABLE 3. Toxin levels for blue mussels collected at King Cove in 2022.

Blue mussel	King Cove	5/25/2022	32.6 ug/100g
Blue mussel	King Cove	6/1/2022	25.6 ug/100g
Blue mussel	King Cove	6/8/2022	26.3 ug/100g
Blue mussel	**King Cove**	**6/16/2022**	**52.8 ug/100g**
Blue mussel	**King Cove**	**6/22/2022**	**72.5 ug/100g**
Blue mussel	**King Cove**	**6/28/2022**	**99.2 ug/100g**
Blue mussel	King Cove	7/6/2022	44 ug/100g

Lake Iliamna

Sockeye salmon livers were collected at Lake Iliamna in July 2022. All were below detectable toxin levels.

Lower Cook Inlet

At the Anchor Point site in Lower Cook Inlet, sockeye salmon livers were collected on 7/5/2022. All samples collected from this site were low or below detectable levels of PSTs.

Sitka

The 2022 Sitka PSP king salmon samples were collected from 5/2/2022 to 7/7/2022 and consisted of Chinook salmon heads, livers, and digestive tracts. The highest level of toxin was for a Chinook salmon liver collected on 5/2/2022 at 78.5 ug/100g. All other samples collected contained low levels of toxins or had non-detectable levels of toxins.

Yukon River

The Yukon River was sampled in two different locations in 2022, from 6/11/2022 through 8/26/2022. These samples consisted of Chinook salmon livers, chum salmon livers, and coho salmon livers. All samples had non-detectable levels of toxins.

Domoic Acid (DA)

In 2022, a total of twenty Domoic Acid tests were run; all were non-detects for DA. These samples were collected from the Yukon River (7) and Homer (13). The samples from the Yukon River consisted of chum salmon livers, while the samples from Homer consisted of sockeye salmon livers (6), chum salmon liver (1), sculpin liver (1), Pacific cod liver (1), halibut liver (1), pollock liver (1), flounder liver (1), and Chinook salmon liver (1).

CHUGACH REGIONAL RESOURCES COMMISSION AND ALUTIIQ PRIDE MARINE INSTITUTE

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HAB role in Alaska

Chugach Regional Resources Commission (CRRC) is a consortium representing seven Tribes in the Prince William Sound (PWS) and the Lower Cook Inlet regions of Alaska (figure 1). CRRC operates the Alutiiq Pride Marine Institute (APMI), located in Seward. In 2021, APMI received funding to conduct monitoring for harmful algae, shellfish biotoxins, and seawater carbonate chemistry across the southcentral region of Alaska through our Chugach Regional Ocean Monitoring (CROM) program.

Summary of activities undertaken in 2022

The current CROM program works with Tribal members in each of our seven communities to conduct ecological and biochemical sampling weekly. Data are recorded onsite, and physical samples are sent to APMI for further analysis.

Algae Species Monitoring: Tribal field samplers currently conduct three-minute phytoplankton tows for visual phytoplankton identification. In 2022, 120 phytoplankton samples were collected and identifed. Capacity for monitoring using quantitative polymerase chain reaction (qPCR) analysis for quantitative speciation is also being developed at APMI and is expected to begin as a monitoring effort in March 2024.

Shellfish Biotoxin Monitoring: Tribal field samplers collect blue mussels and send them to APMI for analysis using ELISAs. APMI is currently working to build in-house laboratory capacity and train our multitude of new staff members in new laboratory techniques such as qPCR and receptor binding assays. CRRC and APMI held their second annual field sampler training on May 5th-6th, 2022.

Summary of key findings/highlights from 2022

From May 2021- September 2022, we tested over 139 bivalve samples (blue mussels, butter clams, cockles, and softshell clams) from various locations in Prince William Sound and Seward. None of the samples collected tested over the FDA regulatory limit (80µg/100g). Our toxin testing and phytoplankton sample results can be found at https://www.alutiiqprideak.org/.

FIGURE 9. Sample sites represented by each of the Chugach Regional Resources Commission Tribes.

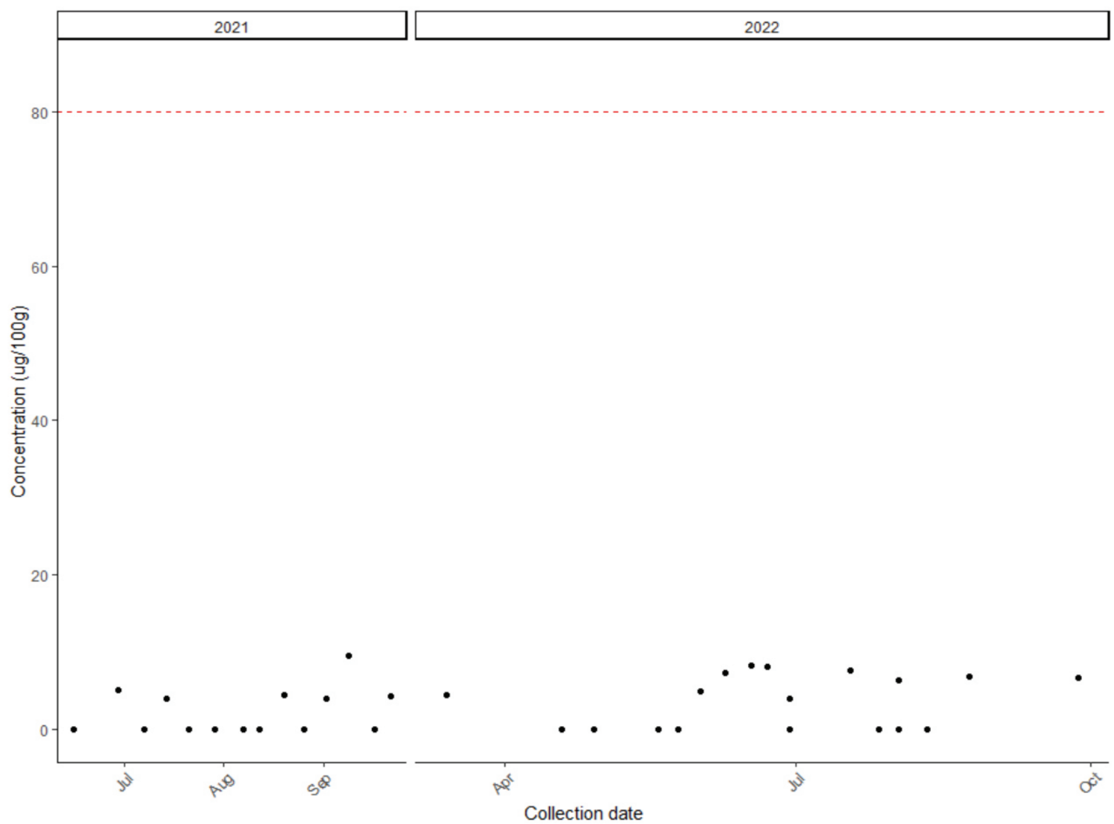

FIGURE 10. Total PST (µg/100g) from blue mussels collected from Resurrection Bay in 2021 and 2022.

Koniag Region (Kodiak Archipelago)

KODIAK AREA NATIVE ASSOCIATION

Andie Wall (andie.wall@kodiakhealthcare.org), **Grace Ellwanger** (Grace.Ellwanger@kodiakhealthcare.org)

HAB role in Alaska

The Kodiak Area Native Association (KANA), provides health and social services for people who live in the Kodiak region. KANA's service area includes the City of Kodiak and the six rural villages of Akhiok, Karluk, Larsen Bay, Old Harbor, Ouzinkie and Port Lions.

Summary of activities undertaken in 2022

With funding through Alaska Ocean Observing System, Andie and Grace were able to continue sampling for HABs at South Trident Basin. Weekly phytoplankton tows were taken and analyzed under a microscope. The presence of phytoplankton species of concern and associated weather and oceanographic parameters were collected and entered in an online database connected to the national Phytoplankton Monitoring Network.

Summary of key findings/highlights from 2022

A total of 29 phytoplankton tows were conducted between May and December 2022. *Alexandrium* was found in two samples (collected on July 7 and July 21, 2022) when water temperatures were 13º and 12ºC, respectively. *Pseudo-nitzschia* was present in 10 samples between June and August 2022, with water temperatures between 9º and 13ºC. *Dinophysis* was present in 5 samples in June, August, and September.

FIGURE 11. Grace Ellwanger (KANA) teaching a HAB water quality workshop. Photo by Andie Wall.

Aleutian and Pribilof Islands

QAWALANGIN TRIBE OF UNALASKA

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HAB role in Alaska

Collection of phytoplankton samples for monitoring of HABs species and mussels for monitoring PSTs in communities around the Aleutians.

Summary of activities undertaken in 2022

During the months of July to December in 2022, Qawalangin Tribe staff collected phytoplankton and ocean acidification samples using a trawl method. A total of 14 samples were collected during this time. The phytoplankton samples were brought back to the Unalaska Fish Hatchery Lab, where they were analyzed for the targeted species. These species are *Alexandrim spp., Ceratium furca, Chaetoceros spp., Dinophysis spp., Nocticula spp., Prorocentrum spp.,* and *Pseudo-nitzschia spp*. Once analyzed, the rest of the phytoplankton sample was shipped to the NCCOS Charleston lab for further analysis. The water temperature was measured during the time that phytoplankton samples were collected. This work was funded by Aluutiq Pride, the Alaska Ocean Observing System, and Alaska Conservation Foundation.

In addition to the water and phytoplankton samples, mussels were tested for PSTs. About 100 grams were collected at Little Priest Rock then shipped to the ADEC EHL lab, where they were tested for PST via mouse bioassays. Sixteen samples were collected, shipped, and tested. Results are published at www.qawalangin.com/psp. This sampling was funded by National Oceanic and Atmospheric Administration

Summary of key findings/highlights from 2022

During the phytoplankton sampling, QTU staff found a consistent presence of HABs species during the months of September and October. There were elevated levels of these species detected during this time period as well (Figure 1).

Unalaska results as analyzed by the ADEC EHL lab are shown below (Figure 3). During the PST sampling, 3 of the 16 samples were found to have a toxin level above the USDA's regulatory limit of 80 µg toxin/100 g shellfish tissue. These samples were collected June 14th, June 21st, and July 12th of 2022.

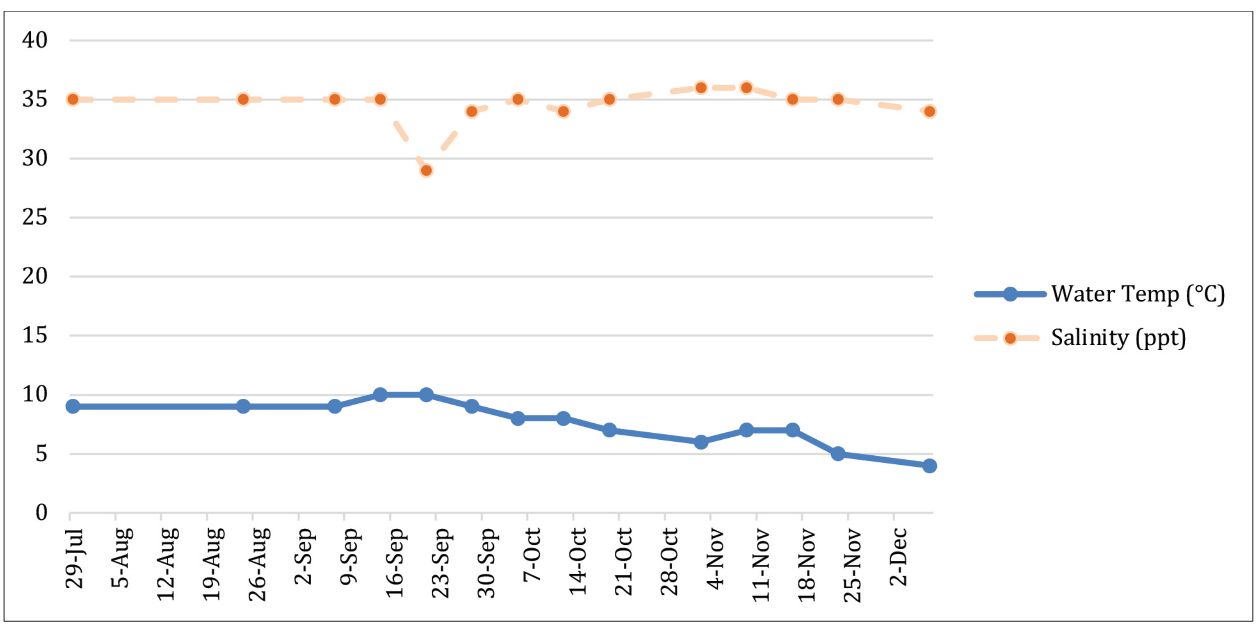

FIGURE 12. Water temperature and salinity taken during the phytoplankton tows efforts.

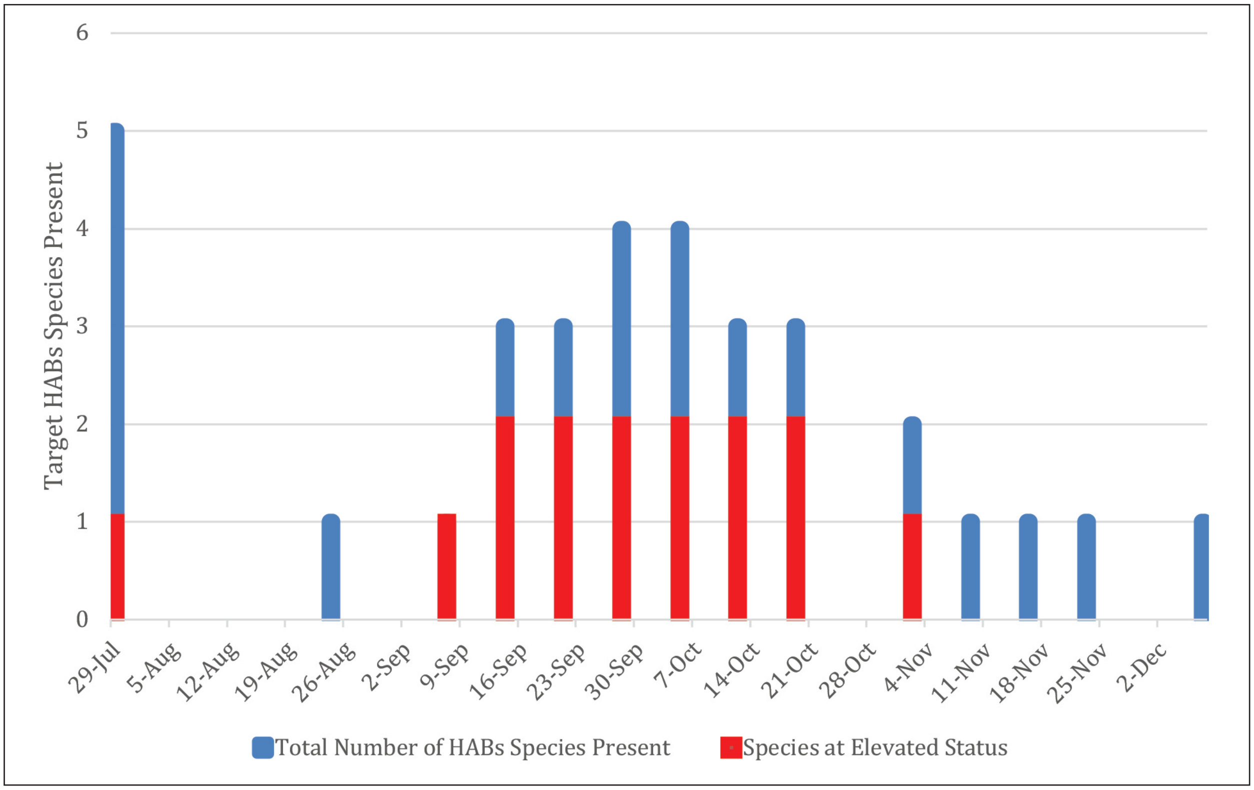

FIGURE 13. Targeted HABs phytoplankton species present in the trawl samples. The red bar is the number of targeted species that were found at an elevated level.

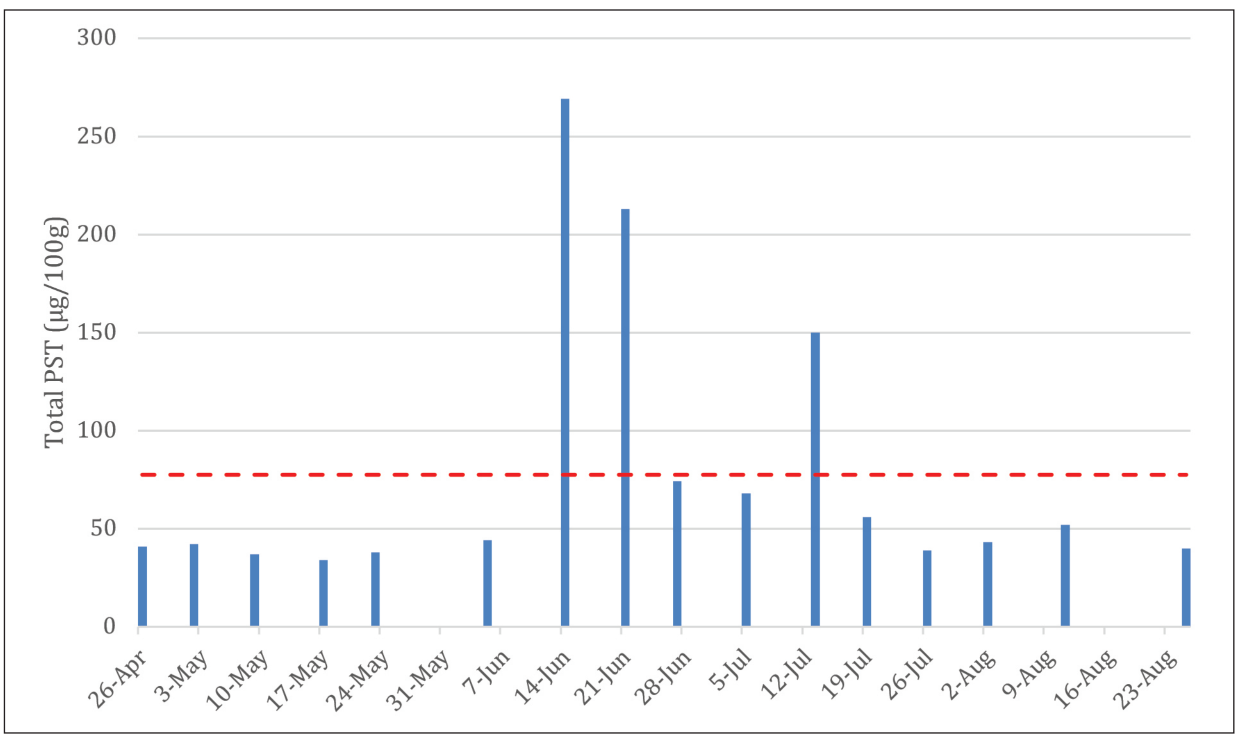

FIGURE 14. PST results from collected *Mytilus edulis*, Blue Mussels for 2022. The USDA's regulatory limit of 80 µg toxin/100 g shellfish tissue is indicated by the red dotted line.

ALEUT COMMUNITY OF ST. PAUL ISLAND

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HAB role in Alaska

The Aleut Community of St. Paul Island Tribal Government (ACSPI) began monitoring harmful algal species in 2022.

Summary of activities undertaken in 2022

The Ecosystem Conservation Office (ECO) established a monitoring site in the small boat harbor. ECO staff conduct weekly three-minute surface phytoplankton tows in the small boat harbor and evaluate with a microscope for phytoplankton identification.

Summary of key findings/highlights from 2022

No samples collected in the summer of 2022 had elevated numbers of toxin producing species. Additionally, ACSPI has partnered with North Carolina State University and assisted in the deployment of solid phase adsorption toxin trackers (SPATTs) and collection of fish from two locations, Antone Lake, and the Small Boat Harbor.

The potential increase in toxic algal species in the Pribilof Islands, driven by changing environmental conditions, is a significant concern for local communities due to the associated risks to commercial, recreational, and subsistence harvesting. Various algal toxins, including both marine and freshwater phycotoxins, pose particular concern in this region. These phycotoxins include: saxitoxins, potent neurotoxins causing paralytic shellfish poisoning in humans, produced by the dinoflagellate genus *Alexandrium*; domoic acid, responsible for Amnesic Shellfish Poisoning in humans, produced by the diatom genus *Pseudo-nitzschia*; and cyanotoxins, originating in freshwater and brackish systems, primarily hepatotoxic microcystins. This pilot effort aims to establish the potential toxin transfer of these common toxins to higher trophic levels by testing animals collected throughout summer of 2022, including fish and benthic species. By assessing whether toxins are detectable in these animals, this novel data can inform ongoing efforts in assessing the risks associated with algal toxins, more specifically with the consumption of fish and shellfish in the area.

FIGURE 15. ACSPI staff collecting water samples for HAB testing on St. Paul Island. Photo by Emily Hearth.

Northern Bering Sea and Bering Strait

NORTON SOUND HEALTH CORPORATION

Emma Pate (epate@nshcorp.org)

HAB role in Alaska

Monitoring for HABs and toxins in the Norton Sound Area.

Summary of activities undertaken in 2022

See activities in the NOAA/NWFSC/WARRN-West/UAF-Alaska Sea Grant/Norton Sound Health Corporation section of this report

LITTLE DIOMEDE

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HAB role in Alaska

The Native Village of Diomede (NVD) implemented a robust environmental monitoring program to generate critical environmental data and information on changing ocean conditions that will be used to establish adaptation and mitigation strategies for traditional harvest of Bering Strait king crabs: *Paralithodes platypus* (blue king crab) and *Paralithodes brevipes* (Hanasaki crab or brown king crab). NVD has a vested interest in protecting traditional and subsistence natural resources and the health of tribal citizens in their traditional tribal territory. Bering Strait king crabs are a key subsistence food source for NVD tribal citizens, yet warming ocean conditions, changes in sea ice dynamics, and shifts in ocean chemistry may be contributing to the decline in subsistence catch off Little Diomede Island.

Summary of activities undertaken in 2022

This project aims to collect key environmental data from known traditional king crab harvest locations to identify changing conditions and inform subsistence harvest decisions. NVD staff work with project partners at Ocean & Earth Environmental (O&E) and UAF's Alaska Arctic Observatory & Knowledge Hub (AAOKH) to conduct water quality monitoring and track sea ice conditions to assess marine conditions. Biological data on harvested king crabs is also being collected to assess population structure of this important subsistence resource. The training, knowledge, and collaboration gained from this project will increase will increase NVD's capacity to assess the community's vulnerability to changing ocean conditions that may have a negative impact on sustainable harvest of traditional foods.

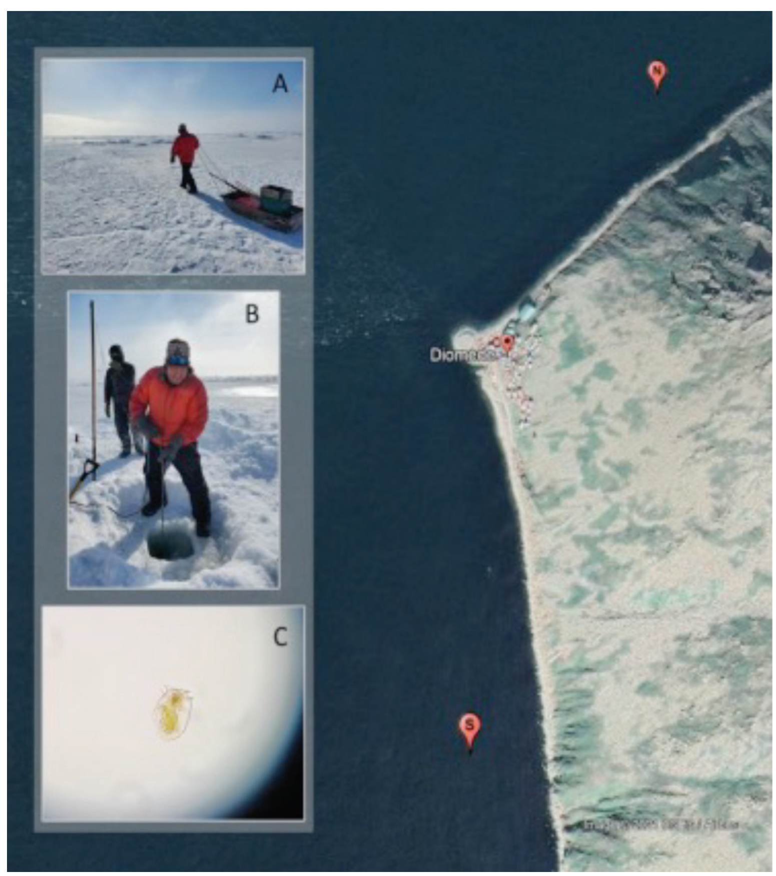

FIGURE 16. Opik Ahkinga (NVD) sampling on Little Diomede Island.

Summary of key findings/highlights from 2022

- Identified all three target Harmful Algal Bloom species in net tow samples in March (under the ice).
- From March to April: 179 Blue King Crab (*Paralithodes platypus*) were measured (50 females and 147 males). 15 crab tissue samples were taken.
- May 20, 2022 was the last handline crabbing day. 47 crabs were measured (17 females and 34 males). No Hanasaki (*Paralithodes Brevipes*) were sampled. 28 Biotoxin samples were collected from these crab tissues.
- Toxin data from Blue King crab viscera had PST and DA present but at very low levels.

Max values measured:

- 33µgPST/100g
- 16ngDA/100g
- 60% of samples had PST
- 12% of samples had DA

Handline crabbing season on ice came late in 2022 due to much young ice movement. On March 3rd, crab-pot holes could be made closer to the village. Traditionally, crabbing areas are about a mile or less, and sometimes further south of Little Diomede. Because the ice is all new ice these days, fishermen are not able to drop lines where crabs are more abundant. Water to the north and south of our islands remains open. In 2022, four plots were established on the south side of Diomede: Plot A & Plot B [N65 44.923', W168 57.007'] are on the same ice sheet, very near each other's crab holes, Plot C [N65 45. 115', W168 57.055], for collecting HABs and OA samples is closer to the village and more shallow with a depth of 20 feet, and Plot D [N65 44.669', W168 56.786'] was established on April 16th further south of the village, on sheet ice with a thickness of 2'6" and a depth of 79 feet. The crabs were more abundant in this area. From April 16 to May 20, NVD staff remained at Plot D to take biotoxin samples from male Blue King crab. The CTD and phytoplankton net were deployed, and phytoplankton samples were taken from Plot D. No tissue samples were taken from female crabs or Hanasaki. On May 20, the ice thickness ranged from 5 to 8 inches in various crab holes. Crabbing took place despite the ice being thin. At the end of the sampling period, 15 crabs were brought back, three of which were taken for biotoxin sampling. This was a better crabbing year for Diomede.

WOODS HOLE OCEANOGRAPHIC INSTITUTE

Don Anderson (danderson@whoi.edu), **Evie Fachon** (efachon@whoi.edu)

HAB role in Alaska

Research on the offshore phytoplankton and HAB community, both in the water column and in the sediment. Work focuses primarily on the Chukchi and Beaufort seas but also includes stations in the Bering Sea.

Summary of activities undertaken in 2022

In summer 2022, scientists from the Woods Hole Oceanographic Institution, University of Alaska Fairbanks, and Oregon State University conducted a collaborative expedition aboard the research vessel *Norseman II*. The purpose of this NSF-funded research cruise was to study the physical oceanography, harmful algal blooms, and biogeochemistry of the region. The ship departed from Nome and sampled locations in the Northern Bering Sea, Chukchi Shelf, and Western Beaufort. The expedition was split into two legs, both departing from and returning to Nome (Leg 1: July 22 - August 14, Leg 2: August 17 - September 6).

Sampling activities during this field effort included collection of surface and subsurface water samples for *Alexandrium* cell enumeration, as well as for species composition and domoic acid content of diatoms in the genus *Pseudo-nitzschia* (all *Pseudo-nitzschia* samples are being analyzed by Katherine Hubbard at Florida Fish and Wildlife Conservation Commission). Net tows were conducted at a subset of stations in order to concentrate the phytoplankton community for analysis of paralytic shellfish toxins (PSTs). Additional concentrated samples were collected from an underway seawater system aboard the vessel. A Smith-McIntyre grab was used to collect

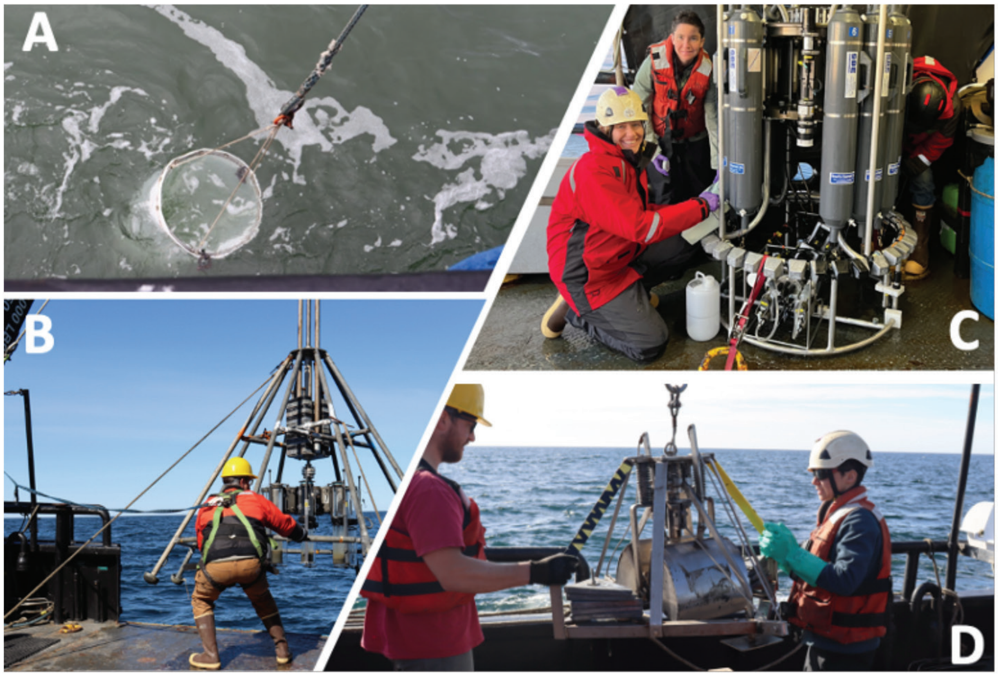

FIGURE 17. Sampling operations aboard the R/V *Norseman II*. A) net tow B) MC-800 multi-core C) CTD Rosette D) Smith-McIntyre grab.

sediment samples for *Alexandrium* cyst abundance, and invertebrates captured in the grab were frozen for PST analysis (conducted by Kathi Lefebvre at NOAA NWFSC WARRN-West). At several locations, a multi-corer was deployed and cores were sectioned for vertical cyst abundance as well as processed for shipboard incubations. Additionally, an Imaging FlowCytobot (IFCB) was configured to sample from the underway seawater system, collecting imagery of phytoplankton along the cruise track.

In addition to the summer field effort, a member of our group sampled for HABs aboard the R/V *Sikuliaq* AON cruise (SKQ2022_15S, November 1 - December 3). During this expedition, water and sediment samples were collected for HAB species abundance, and invertebrates were frozen for PST analysis. A summary of all samples collected during cruises this field season can be found in Table 1. We have also received and processed samples from additional cruises of opportunity (e.g. Northern Bering Sea cruise, BASIS cruise), as well as from shorebased partners in Nome and Diomede (coordinated with Alaska Sea Grant).

TABLE 4. Summary of samples collected for HAB detection during the 2022 cruises. (NRS Leg 1, July 22 – August 14; NRS Leg 2, August 17 – September 6; SKQ2022_15S, November 1 – December 3).

Samples Collected	NRS Leg 1	NRS Leg 2	SKQ	Total
Filtered water samples for *Alexandrium* enumeration	355	317	-	672
Pseudo-nitzschia DNA filters	301	202	111	614
Pseudo-nitzschia toxin filters	301	205	111	617
Surface sediments for *Alexandrium* cyst enumeration	113	22	64	199
Invertebrates (PSTs)	291	4	179	474
Net Tows (PSTs)	33	9	-	42
Underway concentrated toxin samples	19	18	-	37
Sectioned multi-cores for *Alexandrium* cyst distribution	15	0	12	27
IFCB	yes	yes	no	-

Summary of key findings/highlights from 2022

A key finding of the summer 2022 cruises was the detection of a large-scale bloom of *Alexandrium catenella* in the Bering Strait region. This bloom was exceptional in both size and density, with maximum cell concentrations at the surface estimated to be >150,000 cells/L based on IFCB imagery. These values are well above the level required to cause toxicity in shellfish and other consumers. High concentrations of cells were first detected in the Northern Bering Sea, west of St. Lawrence Island, in mid-July (Figure 2). Over the course of the next month, the bloom passed through the Bering Strait and moved east into Kotzebue Sound, eventually advecting onto the Chukchi Shelf. The research team alerted partners at the Norton Sound Health Corporation, Alaska Sea Grant, Alaska Harmful Algal Bloom network, and Alaska Department of Health of bloom observations, and worked with these contacts to craft advisories that could be distributed to coastal communities in the Bering Strait region. The presence of the IFCB aboard the vessel allowed this bloom to be detected and communicated in real time, a first for the region. HPLC analysis of phytoplankton samples collected during the event revealed that the bloom was made up of highly toxic cells, dominated by gonyautoxins 1&4 as well as neosaxitoxin. Analysis of additional samples collected during 2022 field efforts is ongoing.

Research Links

- Lab Website: https://www2.whoi.edu/site/andersonlab/
- IFCB imagery: https://habon-ifcb.whoi.edu/timeline?dataset=arctic
- Strait Science Talk
- PolarTREC project page: https://www.polartrec.com/expeditions/harmful-algal-blooms-in-arctic-waters
- Nome Nugget: http://www.nomenugget.com/news/2022-bering-sea-algal-bloom-was-one-largest-most-toxic-ever-observed-nationwide
- PlosONE Pseud Paper: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0282794

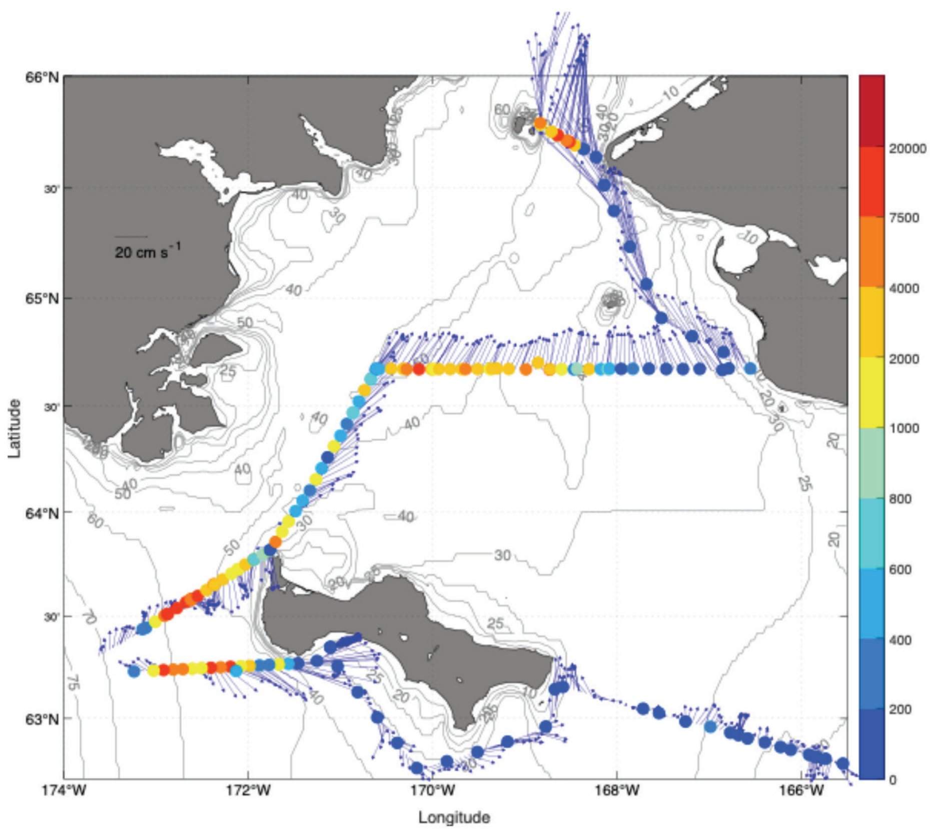

FIGURE 18. Estimated surface densities (cells/L) of *A. catenella* in the Northern Bering Sea and Bering Strait region in late-July 2022 based on IFCB imagery. The arrows indicate current speed and direction measured by shipboard ADCP (see the legend in cm/s).

Chukchi and Beaufort Seas

NATIVE VILLAGE OF KOTZEBUE / SELAWIK NATIONAL WILDLIFE REFUGE / COLUMBIA UNIVERSITY

Alex Whiting (alex.whiting@qira.org), **Bill Carter** (bill_carter@fws.gov), **Ajit Subramaniam** (ajit@ldeo.columbia.edu)

FIGURE 19. Assembling the mooring before deployment (Left); mooring in the water (Right).

HAB role in Alaska

Alex Whiting is the Environmental Director of the Native Village of Kotzebue, specifically interested in the cyanobacteria blooms that occur in Kotzebue Sound during the summer. Bill Carter is a fish biologist with the USFWS Selawik National Wildlife Refuge and is participating in deploying sensors in Kotzebue Sound. Ajit Subramaniam is a research professor at Columbia University with expertise in oceanography, phytoplankton community ecology, and remote sensing.

Summary of activities undertaken in 2022

The Native Village of Kotzebue, Selawik Refuge, and Columbia University collaborated to deploy a mooring off Lockhardt Point to study seasonal changes in environmental conditions that could contribute to the occurrence of cyanobacterial blooms in the waters around Kotzebue.

The mooring was deployed for the duration of the ice-free season and collected data every 10 minutes between the 24th of June and 21st of September. The mooring is powered by a solar panel and had a YSI EXO-2 sonde and a Gill MaxiMet GMX600 weather station. The YSI sonde measured temperature (T), conductivity (salinity - S), dissolved oxygen (DO), turbidity (RFU), fluorescence due to dissolved organic matter (fDOM), fluorescence due to chlorophyll (Chl) and due to phycocyanin (PC). These measurements are the first high resolution record of the environmental conditions for this region through the summer.

Summary of key findings/highlights from 2022

The prime motivation for the mooring was to quantify the magnitude and timing of cyanobacterial blooms using phycocyanin fluorescence. These measurements show a consistent increase in cyanobacteria beginning at the end of August (Fig 2) and continuing until Typhoon Merbok went over the mooring in mid-September (the effect of the typhoon is seen as the distinct signal in the TS data Figure 2 right).

An unexpected finding was the evidence of Chukchi Sea waters at the surface as far inland as the mooring (Fig 3).

While extreme events such as Typhoon Merbok can be clearly seen as a high salinity spike around the 18th of September. It was surprising to note these types of high salinity events are not uncommon in the summer with five distinct surface high salinity events. Traditional knowledge holds that when the wind blows out of the west, ocean water is pushed into the sound and piles up in Kobuk Lake. While the mooring data is mostly consistent with this, we found that the winds could range from North north west all the way to Southeast to result in high surface salinity at the

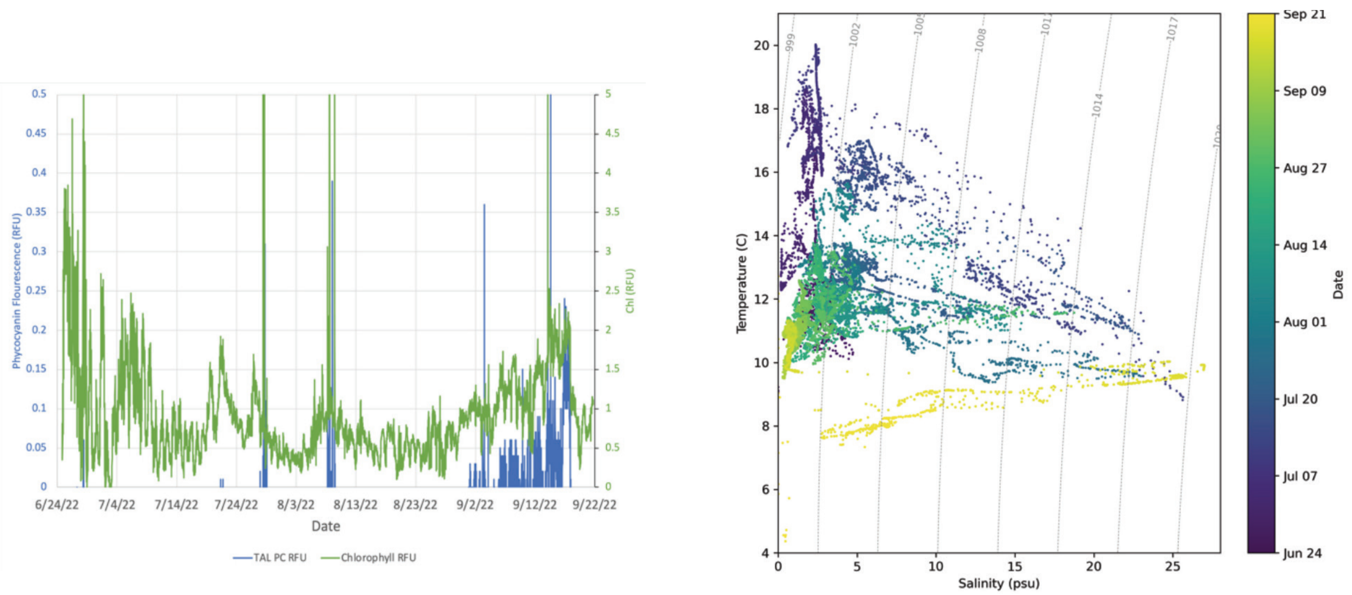

FIGURE 20. Time series of Phycocyanin (PC) and Chlorophyll (Chl) a fluorescence (Left); TS data from mooring (Right, figure courtesy C. Witte).

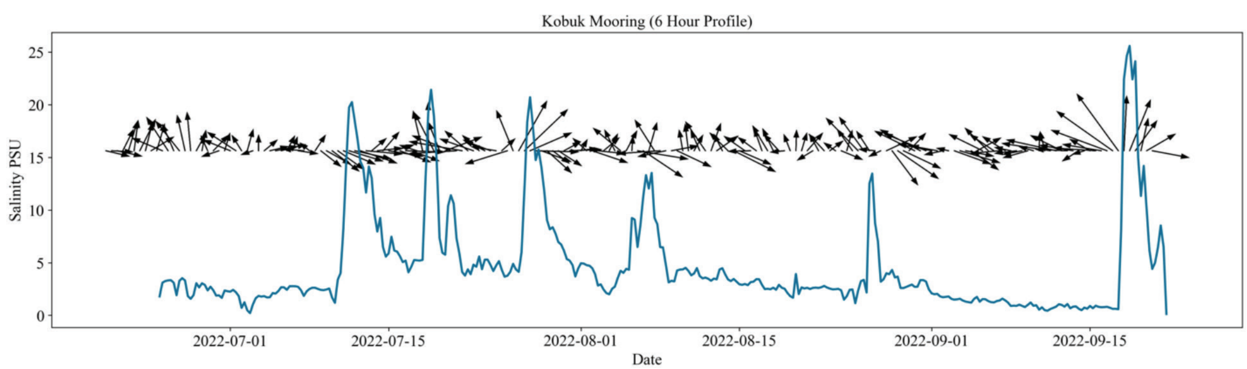

FIGURE 21. Time series of salinity from the mooring and wind velocity from OTZ airport met station (courtesy E.MacLeod).

entrance to Kobuk Lake. One potential consequence is that marine species of phytoplankton including *Alexandrium* could be transported close to Kotzebue. However, it should be noted that these salinity events are short lived, often lasting only a couple of days before the Chukchi Sea waters are flushed out and so any consequences to food safety is unknown. We are working on a Generalize Linear Model to see if we can predict Chukchi Sea intrusions based on wind velocity and duration and the transport of *Alexandrium* to Kotzebue.

We also worked on the analysis of satellite data to explain the Herring mortality event of Fall 2021. Analysis of satellite based chlorophyll concentrations show a general increase in the magnitude of Fall blooms.

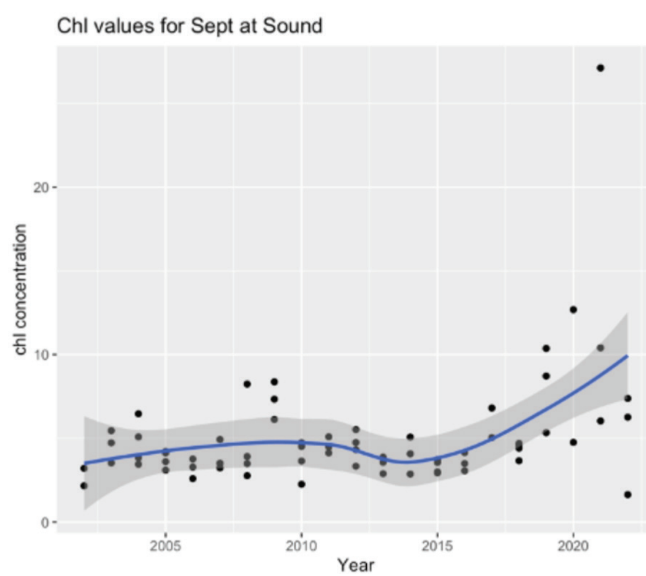

FIGURE 22. Satellite derived surface Chlorophyll concentration in Kotzebue Sound from 2002-2022 (Figure courtesy M. Lehman).

NORTH SLOPE BOROUGH, DEPARTMENT OF WILDLIFE MANAGEMENT

Raphaela Stimmelmayr (raphaela.stimmelmayr@north-slope.org)

HAB role in Alaska

The North Slope Department of Wildlife Management monitors populations of fish and wildlife and supports sustainable harvest of subsistence resources. Staff of the DWM help collect samples to monitor for algal toxins throughout the North Slope Borough.

Summary of activities undertaken in 2022

A total of 52 samples were collected including subsistence harvested, found dead marine mammals, and beach cast invertebrates (Table 1). With the exception of the polar bear feces (voided feces by free-ranging polar bears collected in the field), feces from marine mammals were collected during routine postmortem examination of these species as part of the NSB DWM wildlife health assessment. Feces were stored frozen and shipped to ECOHAB principal investigator Kathi Lefebvre. No abnormal behavior was reported for the subsistence harvested animals (bowhead, beluga, seals, polar bears).

TABLE 5. A summary of feces collected and shipped and to be shipped by NSB DWM (R. Stimmelmayr) to Kathi Lefebvre as part of the ECOHAB project. Time frame 06/01/2022 - 05/31/23.

Species	2022 (shipped 11-14-2022)	2023 (To be shipped)	Total
Bowhead	16	7 (spring harvest)	
Harbor porpoise	1		
Beluga whale	4		
Polar bear	5	1 (free-ranging)	
Walrus	3		
Seals	7		
Invertebrates	7		
Fish	1		
Total	**44**	**8**	**52**

FIGURE 23. Bowhead whales swimming through sea ice. Bowhead whales can accumulate algal toxins through their zooplankton prey. Photo by Amelia Brower.

WOODS HOLE OCEANOGRAPHIC INSTITUTE

Don Anderson, Evie Fachon
(See in the Northern Bering Sea Section)

UTQIAĠVIK / APPLIED RESEARCH IN ENVIRONMENTAL SCIENCES

Laura Thomas (backdirt@gmail.com), **Anne Garland** (awhgarland@yahoo.com), **Evie Fachon** (efachon@whoi.edu)

HAB role in Alaska

Community members of Utqiaġvik (Laura and Bryan Thomas) are working with Applied Research in Environmental Sciences (Anne Garland) to start monitoring for HABs around Utqiaġvik and Point Barrow. Monitors collect water samples and examine them with microscopy both in freshwater lagoons and along the coast.

Monitors began sampling monthly in 2016 at two coastal sites and two lagoon sites. Along the coast, samples for HABs are taken at the Barge Pole Site near the sewage lagoon outflow, and at the 32 Unit Site near Pump Station 3 and the gas station. For the lagoons, samples are taken at Elson Lagoon boat ramp and the Esatkuat lagoon system. The samples are taken from the third lagoon inland above the second dam which is used for drinking water. Unfortunately, runoff from the airport runways occur into this upper lagoon. It is this upper lagoon where a bloom was reported by local sanitation in summer 2021.

Sampling is conducted following the methodology from NOAA's Phytoplankton Monitoring Network. This includes doing a phytoplankton net tow, collecting salinity and water temperature, and identifying phytoplankton on grided slides under a microscope.

Summary of activities undertaken in 2022

In 2022, monthly sampling was conducted as described above. In addition, WHOI conducted an offshore HAB survey, and the chief scientist Dr. Bob Pickart requested the positions for the 2 nearshore sampling sites so the research vessel could come closer to shore for sampling at relevant sites (see the WHOI report in the Northern Bering Sea section of this report for more details on the HAB survey). Offshore of the two Utqiaġvik stations, surface and bottom water samples were collected and a sediment grab was deployed on August 7, 2022.

Summary of key findings/highlights from 2022

As of 2022, monitors in Utqiaġvik had not found any toxic algal species at any of the four sites (two along the coast and two in the lagoons). Offshore samples taken by the WHOI cruise found *Alexandrium* at both stations, but in low quantities (17 to 23 cells per liter) not considered to be dangerous. Surface sediments showed very low *Alexandrium* cyst concentrations (5 to 50 cysts per cubic centimeters), much lower than on the Chukchi shelf and further offshore east of Utqiaġvik. Invertebrates found in the sediment grabs were analyzed for toxin concentrations, but all were found to be below the detection limit or extremely low (4.6 ng/g).

Statewide

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

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HAB role in Alaska

The Alaska Department of Environmental Conservation tests bivalve shellfish harvested from classified shellfish growing areas meant for commercial market for marine biotoxins including paralytic shellfish toxin (PST) in all bivalve shellfish and domoic acid (DA) specifically in razor clams. The Environmental Health Laboratory (EHL) is the sole laboratory in the state of Alaska certified by the FDA to conduct regulatory tests for commercial bivalve shellfish. The EHL also does testing for research, tribal, and subsistence use.

Summary of activities undertaken in 2022

TABLE 6. The Environmental Health Lab performed the following marine biotoxin analyses in 2022.

	Commercial	Non-commercial
Domoic Acid	0	574
Mouse Bioassay	472	58
Liquid chromatography post-column oxidation	0	353

The sole commercial razor clam fishery in Alaska did not operate in 2022 and no regulatory tests for DA in razor clams were conducted.

Summary of key findings/highlights from 2022

There was one farm closure in 2022 due to multiple PST levels above the regulatory limit of 80 µg/100 g of tissue. The commercial harvest area is located in southeast Alaska and had PST levels on the following dates:

- 5/08/22: 386 µg/100 g of tissue,
- 5/12/22: 185 µg/100 g of tissue,
- 5/16/22: 257 µg/100 g of tissue, and
- 5/19/22 : 122 µg/100 g of tissue.

This area remained in the closed status to harvesting until June 6, 2022 when the reopening criteria was met: three consecutive PST tests taken at least four days apart spanning at least 14 days must be below 80 µg/100.

ALASKA DEPARTMENT OF HEALTH, DIVISION OF PUBLIC HEALTH

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Katherine Newell (katherine.newell@alaska.gov), **Anna Frick** (anna.frick@alaska.gov)

HAB Role in Alaska

The Alaska Division of Public Health (AKDPH) actively monitors and manages incidents related to shellfish poisoning in Alaska, focusing on both individual and community health. Recognizing its substantial potential health impact paralytic shellfish poisoning (PSP) in humans is an immediately reportable health condition in Alaska. AKDPH's specific responsibilities encompass various activities, such as collaborating with healthcare providers to obtain samples and offer clinical guidance, conducting interviews with all affected individuals, conducting active case finding, and working closely with other agencies to ensure the timely dissemination of PSP-related warnings throughout Alaska. Furthermore, AKDPH aims to enhance community awareness and mitigate human health risks associated with HABs in Alaska by providing informative materials to the public.

Summary of Activities undertaken in 2022

In 2022, AKDPH identified a single probable case of PSP based on the national case definition for saxitoxin ingestion. However, as this case involved a non-resident it was not included in Alaska's overall case count. Since 1993, Alaska has documented a total of 132 cases of paralytic shellfish poisoning (PSP), with a notable increase in cases reported during the spring and summer seasons. AKDPH remains vigilant in monitoring the epidemiology of PSP cases across the state. For comprehensive information regarding the current epidemiological status of PSP in Alaska, please refer to the latest Epi bulletin on PSP found here: http://www.epi.alaska.gov/bulletins/docs/b2022_05.pdf.

USGS ALASKA SCIENCE CENTER, HARMFUL ALGAL TOXIN LAB

Matthew Smith (mmsmith@usgs.gov), **Caroline Van Hemert** (cvanhemert@usgs.gov), **Danielle Gerik** (dgerik@usgs.gov)

HAB Role in Alaska

Our lab at the Alaska Science Center tests tissues from seabirds, forage fish, and invertebrates for the presence of saxitoxin (STX) and domoic acid (DA). We work with multiple partner agencies and groups to screen tissues collected from mortality events throughout Alaska. We also have ongoing research projects related to harmful algal toxins including experimental trials to assess the effects of STX ingestion on seabirds and tracking the occurrence of die-off events caused by HABs throughout marine waters of Alaska.

Summary of 2021-2022 activities

We continue to screen tissues from die-off and opportunistically collected seabird carcasses submitted through the USGS National Wildlife Health Center (NWHC) or State of Alaska Office of the State Veterinarian for the presence of STX and DA. Seabird carcasses were mostly collected in the Bering and Chukchi Sea region during 2021-2022, with fewer received from areas throughout the Gulf of Alaska. These samples included Black-legged Kittiwakes from two separate die-off events at Middleton Island, and Pacific Herring collected from a mortality event near Kotzebue in October 2021. Additional work included an experimental trial to determine the sublethal and chronic effects of STX ingestion by Common Murres in collaboration with the Alaska SeaLife Center in Seward, Alaska.

Summary of findings/highlights from 2021-2022

A total of 115 seabird samples from 42 individuals were screened during 2021-2022 for the presence of STX and DA, the results of which are listed in Smith et al. (2022). The majority of tissues tested were below detectable levels with the exception of a Tufted Puffin collected in Unalaska in July 2020 and submitted to the NWHC in August 2021. This bird had a maximum STX concentration of 16.9 µg/100g STX in gastrointestinal tissue. Subsequent high performance liquid chromatography (HPLC) analysis showed a diverse suite of paralytic shellfish toxins (PSTs) in tissues, with a total concentration of 22.4 µg /100g STX-eq. These values combined with reports from the region lead to a determination of saxitoxicosis as the cause of death. All samples tested from both Middleton Island die-off events were below detectable levels for both STX and DA. We found quantifiable levels of STX in the majority of Pacific Herring found dead near Kotzebue, Alaska, in 2021. Values ranged from 2.3-15.8 µg /100g, suggesting that these fish were exposed to and possibly died of saxitoxin toxicity. All data produced or referenced here are publicly available and can be found in Smith et al. (2022)

Common murre captive project: Our experimental dosing project assessing the effect of STX ingestion by Common Murres was delayed by over a year due to the COIVD-19 pandemic. We were able to collect murre eggs in July 2021 and conduct our experiments from January-March 2022. The goal of this project was to provide a better understanding of the direct effects paralytic shellfish toxins have on seabirds and provide further insights into their potential role in die-off events. We conducted dose-finding trials to determine the median effective dose (ED50) of purified saxitoxin and a crude extract of *Alexandrium catenella* cells collected from the Chukchi Sea.

These results will help evaluate whether sublethal ingestion of STX could inhibit birds' mobility or access to food in the wild, thereby compromising seabird health without inducing acute toxicity.

STX mortality event publication: In June of 2019, unusual mortality of adult and nestling Arctic Terns occurred at a breeding colony near Juneau, Alaska. The birds' deaths were attributed to saxitoxicosis after detecting elevated concentrations of STX and other PSTs in tern carcasses, forage fish, and shellfish samples collected from tern nest sites and nearby bays where birds were known to forage. Our investigation of the role of STX in this die-off event was published in 2022 in Harmful Algae (Van Hemert et al. 2022). This effort included a diverse group of partners, including the US Forest Service, USGS NWHC, NOAA, US Fish and Wildlife Service, University of Alaska, and Sitka Tribe of Alaska.

Additional information on HAB research at the USGS Alaska Science Center can be found here:
https://www.usgs.gov/centers/asc/science/harmful-algal-bloom-toxins-alaska-seabirds

Smith, M.M., Van Hemert, C., and Gerik, D.E., 2022, Tissue concentrations and congener profiles of harmful algal toxins in seabirds, forage fish, and other organisms (ver. 3.0, June 2023): U.S. Geological Survey data release, https://doi.org/10.5066/P9MLNP9H

Van Hemert, C., J.R. Harley, G. Baluss, M.M. Smith, R.J. Dusek, J.S. Lankton, D.R. Hardison, S.K. Schoen, R.S.A. Kaler. 2022. Paralytic shellfish toxins associated with Arctic Tern mortalities in Alaska. Harmful Algae: 102270.

USGS ALASKA SCIENCE CENTER, SEABIRD AND FORAGE FISH ECOLOGY PROGRAM

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Collaborators: **Matthew Smith, Caroline Van Hemert**

HAB role in Alaska

Research and monitoring of harmful algal bloom toxin prevalence in seabirds and their food webs.

Summary of activities undertaken in 2021 and 2022

We collected food web samples at monitoring sites (Juneau, Prince William Sound, and lower Cook Inlet), and collaborated with partners (Sea Grant Alaska, UAF, USFWS Alaska Maritime National Wildlife Refuge, USFWS Migratory Birds, Institute for Seabird Research and Conservation on Middleton Island, National Park Service, USGS Nearshore Marine Ecosystem Research Program) to collect samples of seabirds, forage fish, and invertebrates elsewhere (multiple sites around the Bering Sea, Middleton Island, Katmai/Kenai Fjords, Glacier Bay). We also conducted rapid response sampling during known bloom and/or die-off events, including an *Alexandrium* bloom at Unalaska and a multi-species seabird die-off at Middleton Island in 2021.

For more information about USGS Alaska Science Center HABs research, see:
https://www.usgs.gov/centers/asc/science/harmful-algal-bloom-toxins-alaska-seabirds

Summary of key findings/highlights from 2021 and 2022

We analyzed 500 samples for saxitoxin (STX) and 92 samples for domoic acid (DA) using enzyme-linked immunosorbent assay (ELISA) kits between 2021 and 2022. This included 9 seabird species, 16 fish species, 4 crustacean species, numerous plankton species, and 2 mollusk species. STX was detected in 7 seabird species (Horned Puffin, Black-legged Kittiwake, Black Oystercatcher, Glaucous-winged Gull, Thick-billed Murre, Common Murre, Least Auklet), 12 species of fish (Pacific sand lance, Pacific herring, Pacific sandfish, Walleye pollock, capelin, kelp greenling, chum salmon, Pacific cod, Pacific halibut, pink salmon, Chinook salmon, Northern lampfish), 2 species of crustacean (Dungeness crab and Crangon shrimp), plankton, and 2 species of mollusk (blue mussels and limpets).

Concentrations of STX were highest in the GI tract and feces of seabirds and fish and were less prevalent and in lower concentrations in liver, muscle, and kidney. STX was detected in marine food web samples during all sampling events. We are still finalizing DA results. Ultimately, we will combine these results with those previously collected/analyzed from 2015-2020 (Smith et al. 2022) to look for temporal and spatial patterns in toxin occurrence and accumulation among species within marine food webs. Final data on all samples will be posted under the Data tab here.

Specific sampling events

- 2015/2016 Common Murre die-off: We analyzed multiple tissues from 23 Common Murres from the 2015/2016 die-off for STX (n=113) and DA (n=5).
- Glacier Bay 2018-2021: We analyzed 37 samples from 4 species of forage fish for STX.
- Cook Inlet 2020-2022: We analyzed 55 samples comprised of 3 species of birds, 7 species of forage fish, 4 species of crustaceans, plankton, and 2 species of mollusk for STX. We analyzed 21 samples for DA.
- Juneau 2020-2022: We analyzed 70 samples comprised of 8 species of forage fish, Dungeness crab, blue mussels, and plankton for STX, and analyzed 5 samples for DA.
- Prince William Sound 2020-2021: We analyzed 20 samples comprised of Black Oystercatchers, Pacific herring, 2 species of mollusk, and plankton for STX, and analyzed 2 samples for DA.
- Middleton 2021 seabird die-off: We tested 73 samples from Middleton Island for STX, including live and die-off seabird samples (primarily Black-legged Kittiwakes and Glaucous-winged Gulls), and blue mussels, and we tested 13 samples for DA. We also tested blue mussels, Pacific herring, and zooplankton from nearby Prince William Sound where tagged kittiwakes from Middleton had recently been foraging for STX (n=8). The seabird die-off was suspected to have been caused by Avian Botulism Type C (Avian Botulism Type C Identified for the first time in Alaska).
- Unalaska 2021: Following reports of high STX levels in blue mussels by the Qawalangin Tribe of Unalaska, we conducted a rapid response food web sampling effort in Unalaska (HABs and seabirds). We tested 82 samples comprised of 3 seabird species, 5 fish species, blue mussels, and zooplankton for STX, and tested 36 samples for DA.
- Bering Sea 2021: We analyzed 22 samples comprised of 4 seabird species for STX.
- Pribilof Islands 2022: We analyzed 16 samples comprised of 4 seabird species and blue mussels for STX.

These data are preliminary or provisional and are subject to revision. They are being provided to meet the need for timely best science. The data have not received final approval by the U.S. Geological Survey (USGS) and are provided on the condition that neither the USGS nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the data.

NOAA / NWFSC / WARRN-WEST / UAF-ALASKA SEA GRANT / NORTON SOUND HEALTH CORPORATION

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HAB role in Alaska

The role of the Wildlife Algal-toxin Research and Response Network (WARRN-West) at NOAA's Northwest Fisheries Science Center is to provide surveillance for the presence of algal toxins in live or dead stranded marine mammals collected from the entire West Coast of North America. In Alaska, WARRN-West provides surveillance for algal toxins in marine mammals harvested by Alaska Natives for subsistence purposes. Currently, an Alaska focused ECOHAB-funded project entitled "Trophic transfer and effects of HAB toxins in Alaskan Marine Food Webs" combines WARRN-West and multiple partners with the priority of determining the trophic transfer of algal toxins within food webs and the impacts of toxins on individual organisms and food webs. The scientific objectives of the study are to: 1) quantify toxic algal cell densities (*Pseudo-nitzschia* and *Alexandrium*), 2) quantify corresponding toxin concentrations (DA and PSTs/STXs) in phytoplankton, zooplankton, shellfish, finfish, and marine mammals, 3) define trophic transfer pathways in fish and marine mammals, 4) document health impacts in marine mammals and fish in relation to toxin concentrations and bloom densities using behavioral observation reports by fishers and subsistence hunters as well as detailed pathology examinations in opportunistically-collected fresh stranded marine mammals, and 5) use the environmental and observational data generated from objectives 1-4 to develop toxin - trophic transfer models for algal toxin accumulation, biotransformation, and impact in specific food webs under multiple bloom scenarios and to predict future animal mortality events.

Summary of activities undertaken in 2022

Food web sampling continued for the ECOHAB project with collections on 9 research cruises in Arctic and subarctic regions during May to November 2022 (Figure 1). Research cruises (region, time period) included; **EcoFOCI Spring Mooring Cruise** (Bering Sea, May 2022), **RACE: Eastern Bering Sea Continental Shelf** (Eastern Bering Sea, May – August 2022), **RACE: Northern Bering Sea** (Northern Bering Sea, May – August 2022), **SECM Cruise** (Southeast Alaska, July – August 2022), **HABS2022** (Bering, Chukchi, and Beaufort seas, July – September 2022), **BASIS Surveys** (SE Bering Sea, August – September 2022), **Northern Bering Sea** (Northern Bering Sea, August – September 2022), **EcoFOCI Fall Mooring and DBO Cruise** (Bering and Chukchi Seas, September – October), and a **Fall Monitoring Mooring Cruise** [SKQ202215S] (Northern Bering, Chukchi, and Beaufort seas, November 2022). Sediment, water [phytoplankton], zooplankton, krill, clam, worms, sea anemone, snail,

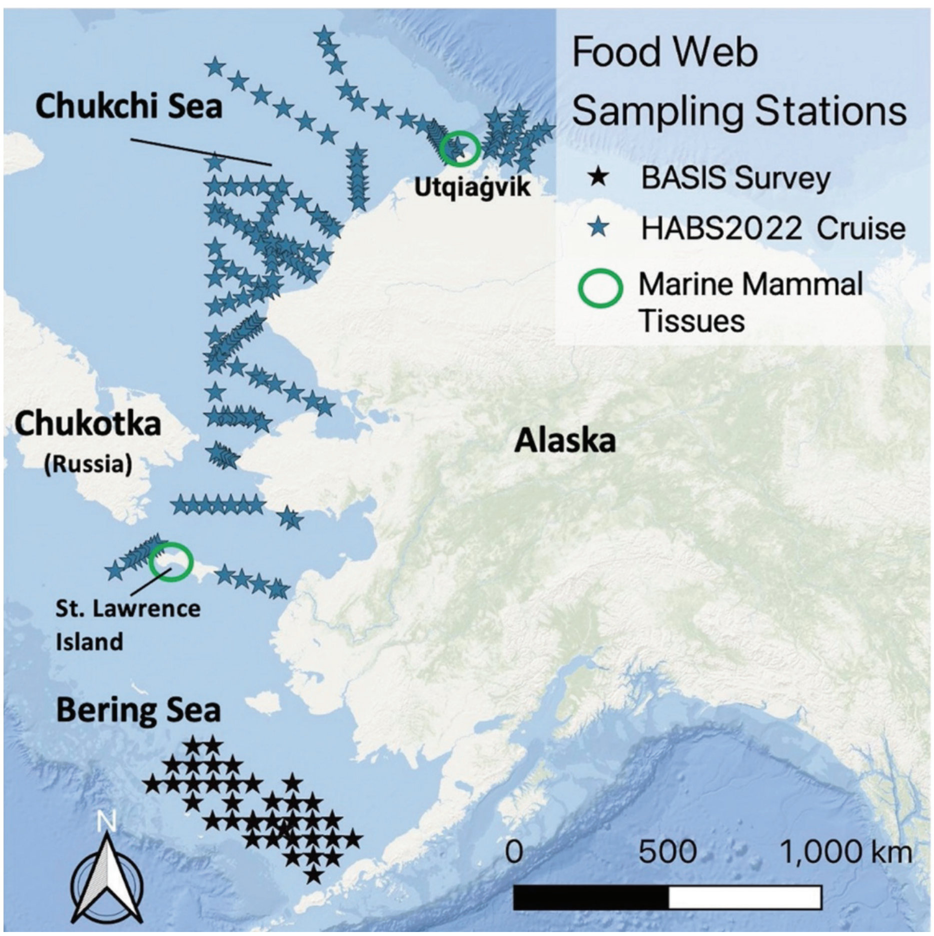
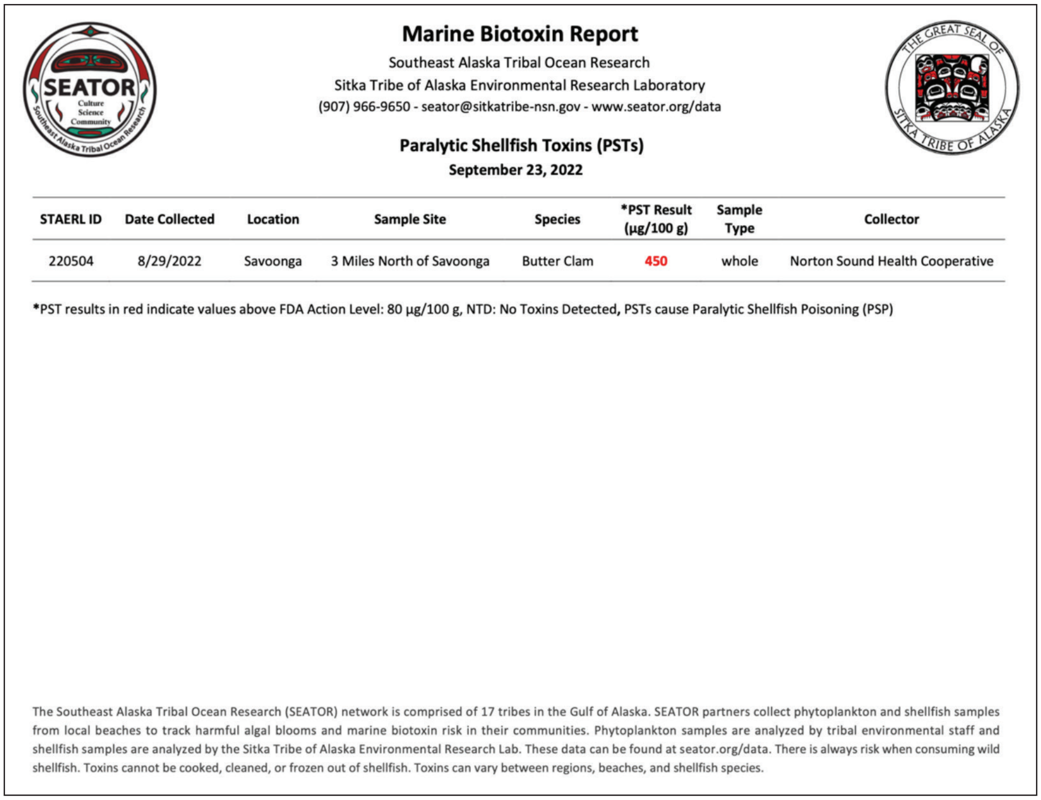


FIGURE 24. Map of two of the nine research cruises' stations (BASIS Survey [purple stars] and HABS2022 Cruise [blue stars]) depicting the expansive Arctic and subarctic areas where food web sampling (sediment, water, zooplankton, invertebrates, and fish) occurred during 2022. Additionally, marine mammal tissues (mostly walruses and bowheads) were collected by Native Alaskan subsistence hunters on St. Lawrence Island and Utqiaġvik (green circles).



Marine Biotoxin Report

Southeast Alaska Tribal Ocean Research
Sitka Tribe of Alaska Environmental Research Laboratory
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Paralytic Shellfish Toxins (PSTs)
September 23, 2022

STAERL ID	Date Collected	Location	Sample Site	Species	*PST Result (µg/100 g)	Sample Type	Collector
220504	8/29/2022	Savoonga	3 Miles North of Savoonga	Butter Clam	450	whole	Norton Sound Health Cooperative

*PST results in red indicate values above FDA Action Level: 80 µg/100 g, NTD: No Toxins Detected, PSTs cause Paralytic Shellfish Poisoning (PSP)

The Southeast Alaska Tribal Ocean Research (SEATOR) network is comprised of 17 tribes in the Gulf of Alaska. SEATOR partners collect phytoplankton and shellfish samples from local beaches to track harmful algal blooms and marine biotoxin risk in their communities. Phytoplankton samples are analyzed by tribal environmental staff and shellfish samples are analyzed by the Sitka Tribe of Alaska Environmental Research Lab. These data can be found at seator.org/data. There is always risk when consuming wild shellfish. Toxins cannot be cooked, cleaned, or frozen out of shellfish. Toxins can vary between regions, beaches, and shellfish species.

FIGURE 25. Marine biotoxin report for a clam collected by a community member from St. Lawrence Island and submitted to the SEATOR lab for PST analysis.

amphipod, shrimp, crab, sea star, and sea cumber samples were collected at various cruise stations for toxin (DA and PSTs/STXs) analysis. Additionally, sediments provided *Alexandrium* cyst densities, while water samples provided cell densities of *Pseudo-nitzschia* and *Alexandrium* phytoplankton. During Spring and Fall of 2022, tissue samples were collected for toxin analysis from walruses and bowhead whales harvested by Alaska Natives for subsistence purposes (Figure 1).

Summary of key findings/highlights from 2022

Algal toxins (DA and STXs) were detected in mostly low to moderate concentrations at all levels of the food web throughout all sampling regions (Bering, Chukchi, and Beaufort seas) for the fourth consecutive year. While most toxin values were low to moderate, we did detect STXs levels at or above the federal seafood regulatory limit (≥80 µg/ 100g) in a few clams. Sample processing is ongoing and similar food web sampling efforts will be conducted in the summer of 2023.

Community sampling highlight

The ECOHAB project's research has helped Arctic coastal communities become more aware of potential risks associated with PSTs accumulating in marine resources utilized as foods in western and northern Alaska. A specific highlight during August 2022, was when a Saint Lawrence Island community member (Figure 1) submitted a large clam for PST analysis to our collaborators, Southeast Alaska Tribal Ocean Research [SEATOR], which came back with PSTs over 5.5x the seafood regulatory limit (450 µg/ 100g). This highlights the importance of working with communities in the Bering Strait region and communicating project results to community members in a timely manner, effectively spreading awareness of potential risks of PSTs in marine resources during a HAB event. Knowledge of PSTs risks associated with food resources allows members to send in samples for testing prior to consumption, potentially avoiding a serious health risk (e.g., paralytic shellfish poisoning, PSP) and saving lives.

NOAA NATIONAL CENTERS FOR COASTAL AND OCEAN SCIENCE

Steve Kibler (steve.kibler@noaa.gov)

HAB role in Alaska

The NOAA National Centers for Coastal and Ocean Science (NCCOS) provide support for research and monitoring of HABs and algal toxins in Alaska. In particular, NCCOS has been conducting several projects in Alaska to better forecast HABs and the distribution of toxins.

Summary of activities undertaken in 2022

MERHAB *Alexandrium* Cyst Project - The project goal is to develop a quantitative PCR assay to more easily estimate *A. catenella* cyst abundance for distribution surveys, cyst monitoring, early warning, and bloom forecast applications. In 2022 sediment from Womens Bay, Kodiak Island was used to create a qPCR standard curve to estimate rDNA copy number per cyst, and to convert number of gene copies in each sample into the number of A. catenella cysts. The Kodiak standard curve was compared with similar curves created in the Gulf of Maine and Puget Sound. The results indicated potentially significant differences in gene copy number in cysts from the three regions. For context, rDNA gene copy numbers were also compared among *A. catenella* vegetative cell strains isolated in each region. While the vegetative cells showed little difference in copy number, there were greater differences among cysts from each location. While the reasons for such differences remain speculative, the end result is that regional standard curves should be used for cyst quantification in each location. Furthermore, data from the Gulf of Maine indicated temporal changes in copy number among seasons may also be significant, so a new qPCR standard curve is recommended for each new cyst survey.

PSP Toxins in the Food Web of Southern Alaska - This 4-year project effectively ended in 2022, where PSP toxin data were compiled for 235 invertebrate samples, 1,511 forage fish samples, and 347 predatory fish samples collected across southern Alaska. Samples were analyzed with a new ELISA protocol developed with SeaTox Research, where L-lysine was used as a reducing agent to transform gonyautoxins present in samples to saxitoxin and neosaxitoxin. The ELISA antibody is highly sensitive to both STX and neoSTX, yielding an ELISA that is more sensitive to GTXs and neoSTX than most other ELISA products.

Among invertebrates, the highest PSP toxin levels were generally present in bivalve consumers, including crabs, sea stars, and predatory snails. In forage fishes, several species showed elevated PST levels, with the highest values in samples of sand lance (Xmax 758 µg STX Eq. 100 g-1), herring (Xmax 428 µg STX Eq. 100 g-1), Pacific cod (Xmax 66.3 µg STX Eq. 100 g-1), tomcod (Xmax 28.5 µg STX Eq. 100 g-1), capelin (Xmax 26.7 µg STX Eq. 100 g-1), surf smelt (Xmax 20.9 µg STX Eq. 100 g-1), and juvenile coho salmon (Xmax 20.7 µg STX Eq. 100 g-1). When average or median values were considered, these high levels were largely masked by many samples with no detectable toxins. Overall, the data indicated 35.3% of forage fish samples collected in Alaska showed detectable levels of PSTs (≥5 µg STX Eq. 100 g-1). In predatory fishes, the maximum PST levels in the tissues examined reached 49.2 µg STX Eq. 100 g-1 in digestive organs, 103.0 µg STX Eq. 100 g-1 in livers, 142.0 µg STX Eq. 100 g-1 in kidneys, 28.3 µg STX Eq. 100 g-1 in muscle tissue, 12.7 µg STX Eq. 100 g-1 in gonads and 26.0 µg STX Eq. 100 g-1 in stomach contents. Across all species, PSTs were detected (> 5 µg STX Eq. 100 g-1) in 60-75% of all tissues tested, with the highest incidence in fish livers (75%) and lowest in stomach contents (61%).

Toxin levels were also compared among different regions of Alaska using combined invertebrate, forage fish and predatory fish data. Interestingly, the combined data indicated the highest toxin levels occurred in samples collected in southeast Alaska (M = 7.33 µg STX Eq. 100 g-1; Q1-Q3 = 0.0 – 31.0), and rank ANOVA results showed this region had significantly greater PST levels than the other locations (H = 90.3, p<0.001). Despite including some of the highest observed toxin levels, the Alaskan Peninsula (M = 2.9 µg STX Eq. 100 g-1; Q1-Q3 = 0.0 – 15.2) and Kodiak Archipelago (M = 3.4 µg STX Eq. 100 g-1; Q1-Q3 = 1.9 – 5.6) sites exhibited significantly lower toxin levels than sites in the southern Bering Sea, the Aleutian islands, the Cook Inlet region, Prince William Sound, or southeast Alaska.

Alaska HAB Forecasting Project - An effort to develop forecasting capacity for HABs was initiated order to provide early warning of particularly severe blooms of I in subsistence-dependent communities in south-central and southwestern Alaska. Much of NOAA's effort in 2022 was focused on developing an *Alexandrium* forecast product in Chiniak Bay, Kodiak Island, with a longer range objective of establishing a forecast for the southwest-southcentral coast. Initial steps included strengthening community-based monitoring for HAB cells and toxins in shellfish and developing a molecular assay for *Alexandrium* resting cysts. Plans in 2023 include obtaining funding to support local monitoring, and establishing a physical model for local circulation in Kodiak.

ALASKA VETERINARY PATHOLOGY SERVICES

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HAB role in Alaska

Alaska Veterinary Pathology Services is a co-investigator on the ECOHABs project. Our role is to facilitate HABs toxin testing of marine mammals in Alaska. In collaboration with the Alaska Marine Mammal Stranding Network, Alaska Department of Fish and Game and several subsistence communities around the state we collect and receive samples from stranded and harvested marine mammals. We also perform targeted full necropsies on marine mammals to survey for HABs toxins and associated effects of HABs toxins. All samples received and collected are forwarded to the WARRN West facility in Seattle and tested for saxitoxin and domoic acid by ELISA. Additionally, we have developed animal behavioral surveys that have been incorporated in Alaska Stranding network protocols to document possible HABs-related toxicity and have developed a shared running log where these observations are recorded and are available for all ECOHABs collaborators to contribute wildlife observations that may be associated with HABs exposure in the course of their work.

Summary of activities undertaken in 2022

From January-December 2022 AVPS collected and/or received 19 samples from stranded or harvested marine mammals for HABs toxin testing. We also performed 5 targeted necropsies on mammals with suspicion of HABs exposure and 10 abnormal behavioral observations.

Summary of key findings/highlights from 2022

Most of the marine mammals tested were from the Southcentral region of Alaska and had either non-detectable or low levels of exposure in 2022.

Looking forward

We are seeking additional behavioral observations and marine mammal carcasses to examine for HABs in 2023 and 2024. Please contact us at avps.natalierouse@gmail.com or avps.kbh@gmail.com to report a dead stranded marine mammal or unusual behavior observed by a wild animal (any species).

Alaska
Harmful Algal Bloom Network

For additional information, please contact

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