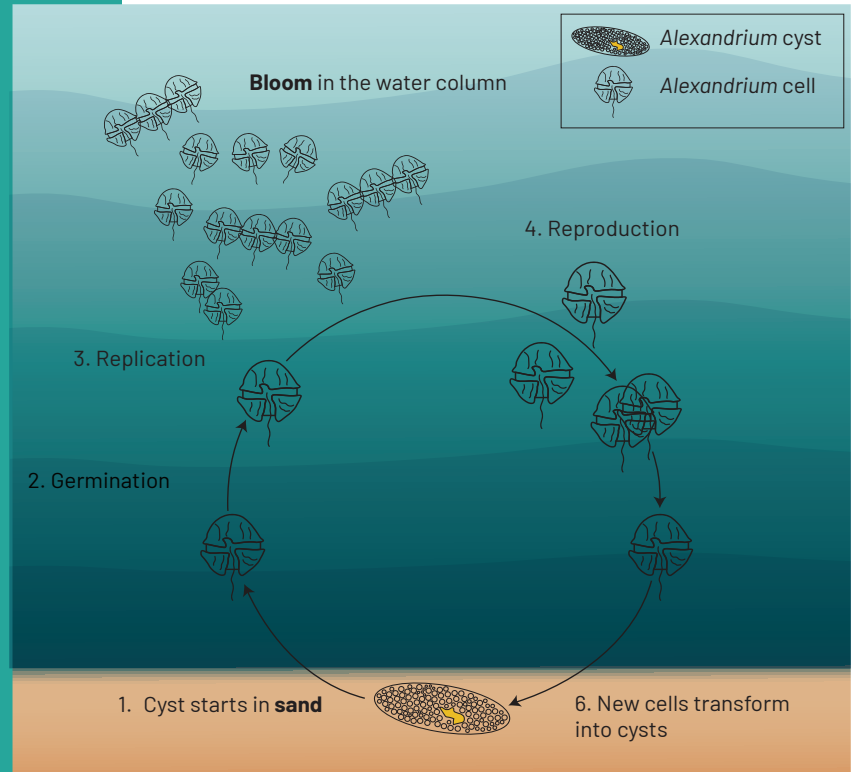


# Harmful Algal Blooms

## Overview

Harmful Algal Blooms (HABs) occur when certain phytoplankton species bloom and produce toxic compounds that accumulate in marine organisms when consumed. These toxins can cause diseases like Paralytic Shellfish Poisoning (PSP). In Alaska, the main source of these toxins is *Alexandrium catenella*, which releases Paralytic Shellfish Toxins (PSTs) that build up in shellfish, fish, birds, and marine mammals. Since 1973, at least 15 Alaskans have died from PSP – all during non-commercial harvests, indicating a disproportionate impact from subsistence and recreational harvests. Monitoring HABs requires funding for sampling and lab testing. This infrastructure is more established in urban-based regions with long-standing PSP activity like Southeast Alaska and Kodiak. However, warming oceans are creating new HAB risks in Western Alaska, where laboratory and testing infrastructure is limited.



HAB lifecycle adapted from U.S. National Office for Harmful Algal Blooms at Woods Hole Oceanographic

## HAB formation: what is a bloom?

*Alexandrium* cells begin as **cysts** (Stage 1 in the figure above) in the seafloor, and can remain dormant for multiple decades. The cells **germinate** (Stage 2) into a swimming stage when conditions such as water temperature, oxygen, nutrients, and light are right for growth. Then, they **rapidly divide** (Stage 3), increasing their cell concentration, sometimes producing and releasing **toxins** into the water column. Once conditions become unfavorable for growth, the cells stop dividing, reproduce, and re-enter the cyst stage, ready to bloom again (Stages: 4, 5, 6). A “bloom” occurs when the cell concentration at Stage 3 surpasses **1,000 cells/liter (advisory limit)**. This is separate from the **regulatory limit**, which is a legally determined threshold of PSTs found in a marine organism’s **tissue** (above which consuming the organism may cause PSP). Both **advisory** and **regulatory** limits are used to inform communities of HAB-related risks.

# HABs and PSP through history\*

# HABs through history (cont'd)

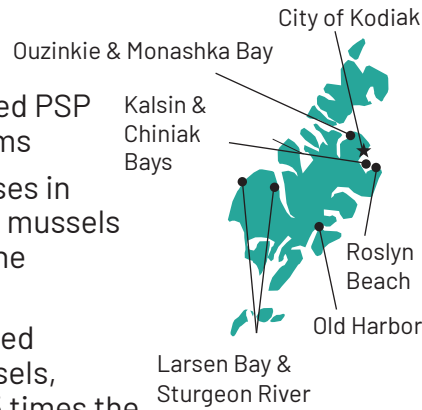
## North Slope to Aleutian Islands

- July 1980: 1 PSP case at **King Cove** from butter clams, patient medevaced to Anchorage
- Aug. 1982: 5 PSP cases in **Perryville** from mussels tested at 62 times the regulatory limit
- June 1990: 5 PSP cases, 1 PSP death, butter clams near **King Cove**
- April 1995: 7 PSP cases in **Perryville** from razor clams tested at 12 times the regulatory limit
- May & June 2012: Pacific Walrus\*\* off of **St. Lawrence Island** tested positive for saxitoxin
- 2014: Suspect PSP case recorded in Nome Census Area
- Aug. & Sept. 2017: Pacific Walrus die-off, 37 walrus found dead near **Diomedede** and **Shishmaref**, 1 of 37 had detectable saxitoxin concentrations above the regulatory limit
- Aug. 2018: HAB detected in northern Bering Sea by icebreaker USCGC *Healy*
- July 2019: 1 PSP case in **Perryville** from butter clams
- Aug. 2019: HAB detected in northern Bering Sea by icebreaker *Healy*, clams near **St. Lawrence Island** and **Cape Lisburne** tested above the regulatory limit
- July 2020: PSP Death in **Unalaska** from blue mussels tested at 100 times the regulatory limit
- Dec. 2021: Multiple beached herring in **Kotzebue** tested positive for saxitoxin
- June & July 2022: **King Cove** shellfish advisory, Razor clams tested 6-7 times the regulatory limit, mussels tested at the regulatory limit
- Aug. 2022: Largest, most toxic *Alexandrium* bloom ever in the US detected in the **Bering Strait** by the *Norseman II*. Clams and gastropods tested above regulatory limit.
- Aug. 2023: *Alexandrium* bloom in **Bering Strait** linked to clams and worms testing above regulatory limit.
- Summer 2024: *Alexandrium* bloom detected in Bering Sea, northern fur seal mortality event on **St. Paul Island**
- July 2025: *Alexandrium* bloom detected in Bering Sea, seabird and northern fur seal die offs on **St. George Island**



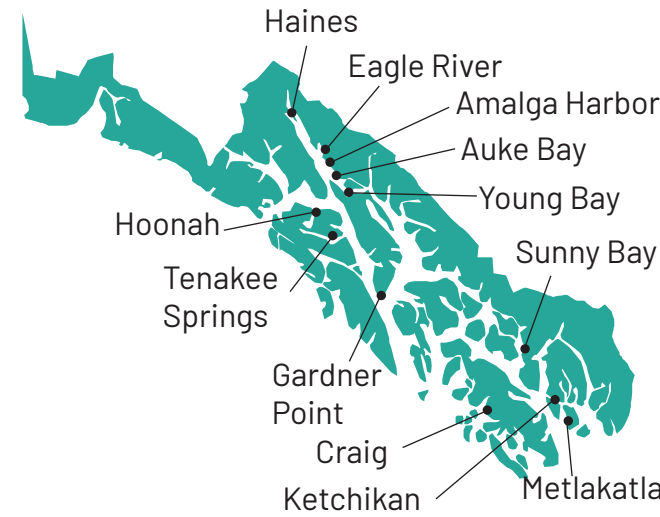
## Kodiak

- May 1976: 1 confirmed PSP case from razor clams
- July 1987: 2 PSP cases in **Monashka Bay** from mussels tested at 70 times the regulatory limit
- July 1990: 1 confirmed PSP case from mussels, shellfish found at 25 times the regulatory limit
- May 1994: 16 confirmed PSP cases around Kodiak, 1 PSP death from mussels, 3 patients required hospitalization in **Kalsin Bay** and 1 death in **Old Harbor**, mussels tested at ~230 times the regulatory limit at **Chiniak Bay** and **Old Harbor**
- February 1995: 1 confirmed PSP case from butter clams tested 2-3 times the regulatory limit
- June 1997: 3 confirmed PSP cases, 1 PSP death near **Sturgeon River Lagoon** and **Larsen Bay** from butter and littleneck clams tested at 100 times the regulatory limit.
- Summer 2012: Kittlitz's Murrelet nestling die off tied to high saxitoxin levels in prey sand lance
- July 2014: Butter clam levels reported as highly toxic at **Old Harbor** (2-2.5 times more toxic than the rest of the island)
- July 2016: 1 confirmed PSP case at **Roslyn Beach**, butter clams tested at 8 times the regulatory limit in **Old Harbor**
- April, Aug., Dec. 2018: Butter clam levels reported as highly toxic at **Ouzinkie** (2-2.5 times more toxic than the rest of the island)
- May & June 2019: State shellfish advisory, butter clam toxin levels high (some 50 times the regulatory limit)
- June 2021: Region-wide shellfish advisory, all species tested high in the **City of Kodiak** and **South Trident Basin** (including mussels, butter clams, oysters, and moon snails)



## Southeast

- Aug. 1973: 2 families report PSP from butter clams in **Tenakee Springs**
- June 1980: 2 PSP cases reported from butter clams which tested at 22 times the regulatory limit at Sunny Bay near **Wrangell**
- July 1980: 2 PSP cases reported from mussels near **Young Bay** and **Eagle River**. Both people medevaced to Juneau
- May 1982: 14 PSP cases reported in **Ketchikan** and **Craig**. Butter clams, cockles, and mussels all tested at dangerous PSP levels, one clam found at 151 times the regulatory limit
- June 1997: 2 PSP cases
- Nov. 1997: 4 PSP cases reported from butter clams at **Auke Bay** and **Amalga Harbor**. Both families "taste tested" clams but still got sick
- June 2010: 3 PSP cases, 1 death in **Haines** from dungeness crab viscera, 1 death in **Auke Bay** from cockles tested at 25 times the regulatory limit
- May 2011: 5 confirmed, 8 probable PSP cases in **Metlakatla** from cockles and 3 confirmed, 5 probable cases in **Ketchikan** from mussels, littleneck, and butter clams. Cockles tested ~6.25 times the regulatory limit, mussels tested at 62 times the regulatory limit
- Dec. 2014: PSP case reported in the Southeast region from 4 butter clams
- May & June 2019: State shellfish advisory. Butter clam toxin levels high (some 50 times the regulatory limit)
- June 2021: Region-wide shellfish advisory. All species tested high in **Hoonah** and **Ketchikan** (including mussels, butter clams, oysters, and moon snails)



## Kenai Peninsula

- June 1977: 17 PSP cases reported in **Homer** from sea snails
- Sept. 2025: Saxitoxin event at **Kachemak Bay**. At Yukon Island, Homer Harbor, Gull Island, and Peterson Bay, butter clams tested at 1.5 times regulatory limit and blue mussels as high as 2 times regulatory limit



## Event Spotlight: 2022 Bering Strait

In 2022, researchers aboard the *Norseman II* in the Bering Strait region detected the largest, most toxic HAB event ever recorded in the United States, an area with historically low PSP rates. *Alexandrium* cell concentrations were up to 173,000 cells per liter, 173 times the advisory limit of 1,000 cells/liter. Though the shellfish toxin levels were pending lab analysis, regionally-based Alaska Sea Grant and Norton Sound Health Corporation in Nome worked to notify Bering Strait regional community leadership and healthcare facilities by providing awareness, education, and updates. While there were no PSP reports in people, results for harvested seafood sent for testing showed saxitoxin at 5 times the regulatory limit, marking a close call.

\* This timeline is non-exhaustive. It only includes events pertaining to the *Alexandrium* genus and non-commercial harvests. Many PSP cases go unreported.

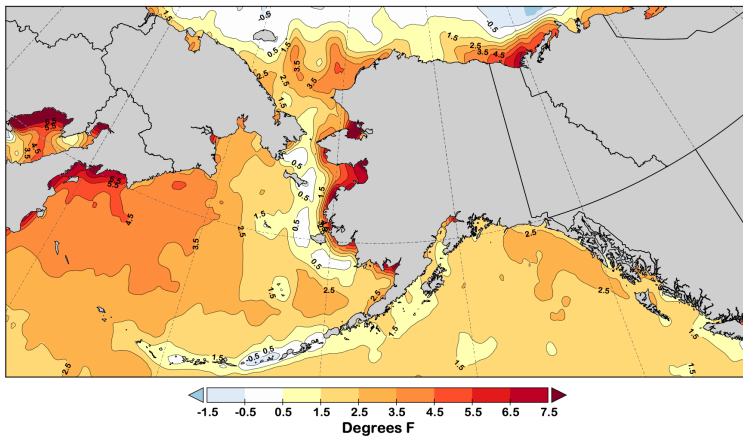
\*\*The Pacific Walrus is an important nutritional and cultural food source for people throughout Northern and Western Alaska

# Changing impacts

## HABs and ocean temperatures

Alexandrium germinate in response to certain environmental conditions, particularly ocean temperatures above 8°C, which have been more common in all Alaskan waters over the last few decades. Recent research from Woods Hole Oceanographic Institute designates a metric called **heating degree-days (DD)**, a measure of **accumulated heat**.

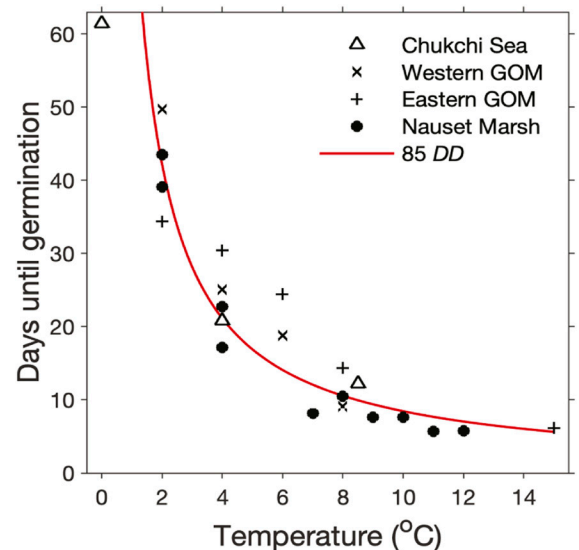
## Change in Summer Average Sea Surface Temperature: June–August, 1982–2025



Data Source: NOAA/PSL/ESRL

## Germination by region

Alexandrium cells from the Chukchi Sea require 85 DD (red line) to germinate, which encompasses conditions from over 60 consecutive days at 0°C (left) to 5 days at 14°C (right). Warmer conditions occur **more frequently** now than in the past due to **ocean warming, increasing HAB risks** in the Bering and Chukchi seas off of **Western Alaska**.



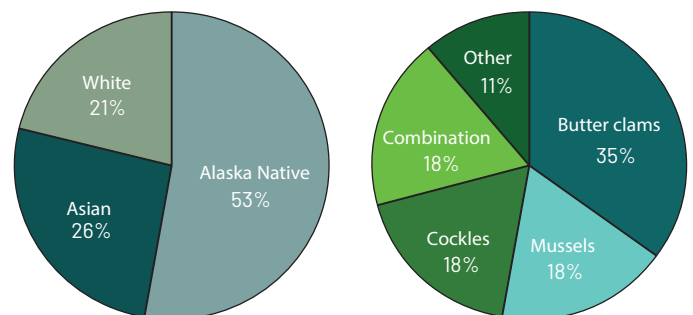
## HAB fast facts

- **53%** of reported **PSP** cases from 1993–2021 were **Alaska Native**, reflecting a higher reliance on non-commercial harvests
- **35%** of PSP cases in Alaska waters from 1993–2021 were from consuming **butter clams**, **18%** from **mussels**, **18%** from **cockles**, and **18%** from **shellfish combinations**.
- Alaska Department of Environmental Conservation (DEC) is required to test only **commercial shellfish** for PSTs
- **DEC recommends NO non-commercial harvest of shellfish in Alaska waters**

## PSP demographics

A higher percentage of PSP cases occur among Alaska Natives

Many kinds of shellfish carry PSP



Source: 1993–2021 State of Alaska Epidemiology Bulletins

Explore other extreme events at [uaf-accap.org/projects/extreme-events-library](https://uaf-accap.org/projects/extreme-events-library)

Sources: Anderson et al. Evidence for massive and recurrent toxic blooms of Alexandrium catenella (2021), Alaska Epidemiology Bulletin, Alaska Federation of Natives, Alaska Harmful Algal Bloom Network, Alaska Sea Grant Marine Advisory Program, Alaska Sea Grant: Walrus and Saxitoxin, Centers for Disease Control and Prevention, Kibler et al. Paralytic shellfish poisoning toxins in butter clams (2022), Knik Tribe, Lago et al. Physical Drivers of a Massive Harmful Algal Bloom (2025), Lefebvre et al. Prevalence of algal toxins in Alaskan marine mammals (2015), Lefebvre et al. Saxitoxin Linked to Deaths of Northern Fur Seals (2025), Qawalangin Tribe of Unalaska, SEATOR, Shearn-Bosler et al. Fatal Paralytic Shellfish Poisoning in Kittlitz's Murrelet (2014), Woods Hole Oceanographic Institute

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