Connie Melovidov holds a tagged snow crab in spring 2022 during a pilot study to monitor winter and spring movements in the Bering Sea. Photo by Garrett Dunne.
WELCOME

The Bering Sea is experiencing many changes. These pages share observations and research that is happening in and around the region. This year’s report focuses on six topics identified by our Community Advisory Panel. The Alaska Ocean Observing System and International Arctic Research Center compiled the information from many sources, with funding from National Oceanic and Atmospheric Administration.

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Community Advisory Panel

We thank our advisory board for providing direction and feedback.

Chandra Poe, Qawalangin Tribe Of Unalaska
Connie Melovidov, University of Alaska Fairbanks
Craig Chythlook, UAF
Jennifer Hooper, Association of Village Council Presidents

Lauren Divine & Chris Tran, Ecosystem Conservation Office at Aleut Community of St. Paul Island
Mabel Baldwin Shaeffer, Alaska Fisheries Science Center
Melissa Maktuayaq Johnson, Interagency Arctic Research Policy Committee

Report background
The Bering Region Ocean Update project began in spring 2020. Bering Science is one aspect of the project aimed at increasing regional data sharing among federal, state, community and private sector partners. This report is a resource for state, federal, community and university partners to share recent observations with community members, other scientists and management agencies. Read previous updates and learn how information is gathered and reviewed at https://aoos.org/beringregion.

Featured topics include research by:
- Alaska Center for Climate Assessment & Policy
- Alaska Department of Fish & Game
- Coastal Observation and Seabird Survey Team
- Eskimo Walrus Commission
- NOAA Alaska Fisheries Science Center
- Norton Sound Economic Development Corporation
- UAF College of Fisheries and Ocean Sciences
- U.S. Fish and Wildlife Service
- USGS Alaska Science Center
- Many others including community members and citizen scientists who contribute to studies in the Bering Sea

Let’s connect
Follow us on Facebook @BeringRegionOceanUpdate. Call us at (907) 644-6756 or email berthingregion@aoos.org.

Cite this report

Feedback
Your opinion is valuable to us and can help guide future reports. Please provide feedback by filling out the postcard in this report or an online survey www.surveymonkey.com/r/BeringScience2022.
Salmon failed to return to western Alaska rivers in 2021. King, chum and silver salmon runs of all ages were impacted. These declines continue to cause severe hardship to communities in the region. Scientists and managers don’t know yet the exact reasons for the declines, but many studies are working to better understand salmon in the Bering Sea.

What do we know?

- Yukon River Chinook salmon abundance is driven by events very early in their life, before their first winter at sea. This is a particularly critical time in the life of salmon, when they face significant challenges to their survival.
- Managers are now able to accurately forecast Yukon River Chinook salmon run abundance up to 3 years into the future. This helps managers and subsistence users plan ahead.
- Changes in the marine environment affect salmon abundance, health and survival. New evidence suggests that marine heatwaves in the Bering Sea and Gulf of Alaska may be responsible for the chum declines. Warming ocean temperatures change the distribution and abundance of nutritious food for young salmon in the ocean. Scientists have found more young chum with empty stomachs and depleted fat reserves in the Bering Sea.

What don’t we know? Too little is known about what happens to salmon in the ocean. Poor abundance isn’t just a problem for Chinook and chum salmon entering the northern Bering Sea (mostly from Yukon River and Norton Sound stocks). Chinook and chum salmon entering the southern Bering Sea (mostly from Kuskokwim River and Bristol Bay stocks) also declined in 2021.

Research priorities Future research will assess juvenile Kuskokwim and Bristol Bay salmon that rear in the southeastern Bering Sea. Since chum (and other species) in western Alaska use both the Bering Sea and North Pacific Ocean during their marine life, a new study will look at what happens to salmon in the North Pacific Ocean.

Who’s doing the research? Responding to marine salmon information needs, the Alaska Department of Fish and Game created the Salmon Ocean Ecology Program (contact: Katie Howard). They assess and monitor the marine life of Alaska salmon. The program collaborates with NOAA and other partners to assess salmon, including western Alaskan salmon, throughout the North Pacific Ocean and Bering Sea.

Stay updated ▶ www.facebook.com/ADFGUnderseaWorldOfSalmonAndSharks

Feedback! We appreciate receiving information, input and developing partnerships with other organizations who also want to learn more about the marine life of salmon. By working together, we hope research will benefit the food security, fisheries management and economic stability of the region. Email kathrine.howard@alaska.gov.
Warm water & salmon stress

The low salmon returns followed several years of warm conditions in the Bering Sea and rivers from the Kuskokwim to the Yukon. In summer 2019, community members raised the alarm to scientists and managers. They reported bathtub-like river water and dead salmon that still had eggs, meaning they died before spawning.

Where were dead salmon found? All five species of salmon were found from Prince William Sound and Bristol Bay in the south, to Norton Sound and the Yukon River in the north. Dead pink salmon were the most abundant in Norton Sound, chum in Yukon and Kuskokwim rivers, and red salmon in Bristol Bay. July marked the peak numbers of carcasses in western Alaska. This timing aligned with the warmest temperatures and lowest river levels.

Why is warm water bad? Salmon need cool, oxygen-rich water to migrate, spawn and rear their young. Many rivers and streams still provide great salmon habitat, but some areas are becoming warmer and drier due to climate change.

Lab tests showed that about 50% of king salmon returning to the Yukon River in 2016 and 2017 were stressed by the warm water. In other regions, this kind of stress has been tied to death before salmon are able to spawn.

What does this mean for managing salmon? When salmon die before they spawn, the number of salmon entering rivers no longer provides an accurate estimate of how many eggs are laid in the gravel. This makes managing salmon and estimating the size of the next generation more challenging for managers.

Who's doing the research? Alaska Science Center, US Geological Survey (Contact: Vanessa von Biela)

Read more ▶ https://doi.org/10.1002/fsh.10705

Report unusual salmon observations, like carcasses with eggs or salmon avoiding warm water, to leonetwork.org.
Mimicking the fishery

**Question:** Do chum and silver salmon captured in the Unalakleet and Shaktoolik commercial fishing subdistricts spawn in rivers within the same subdistrict? Or, are fish potentially being intercepted on their way to other subdistricts?

**What are the study methods?** Biologists use gillnets to capture fish completing their ocean migration in Norton Sound. The live fish are transported to a tank on a skiff. After recovery, they are tagged with tiny sound-emitting devices and released. As tagged fish swim throughout eastern Norton Sound and into the river mouths their locations are logged by receivers.

At the end of the summer the receivers are retrieved and the fish movement data downloaded. This is a major improvement from the last tagging study that took place in the 1970s, which required each tagged fish to be recatched to retrieve the data.

**How will the information be used?** This study mimics the commercial chum and silver salmon fishery because fish are tagged in the same areas where fishing boats operate in Unalakleet and Shaktoolik subdistricts. The results will help managers ensure that salmon runs are managed to provide equitable and sustainable harvests, especially as salmon extend their range northward with climate change.

**Timing:** Began in 2020

**Who’s doing the research?** Norton Sound Economic Development Corporation (contact: Ashley Dunker); UAF College of Fisheries and Ocean Sciences (contact: Luke Henslee); Alaska Department of Fish and Game

**Read more ►** [www.nsedc.com/salmon-acoustic-tagging](http://www.nsedc.com/salmon-acoustic-tagging)

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**Do silver salmon mix between stocks?** Most silver salmon available for harvest in the Unalakleet subdistrict came from Unalakleet stock. Within the Shaktoolik subdistrict however, a large portion of the silvers came from other stocks. [Graph by Luke Henslee.](#)
Sea ice loss is threatening Pacific walrus habitat. Other climate change related factors such as ocean acidification, increased shipping and more development in the North are also a concern for walrus. This graph shows the Bering Sea ice extent from November to April, 1978–2022. The past decade, much of which had below normal ice extent, is in red. *Graph by Rick Thoman.*

### Climate change and walrus

**Questions:** How is climate change impacting walrus? What is their survival and abundance?

**What are the study methods?** Several studies are taking place during a scientific research cruise in the Northern Bering and Chukchi seas:

- Tissue samples will be collected from walrus hauled-out on sea ice. The samples will be collected using biopsy darts launched from a crossbow. The darts punch a section of skin and fat about 1/4 of an inch in diameter. Darts are connected to floats so that the samples can be retrieved with minimal disturbance to the walrus.

- Count and record the ages of walrus encountered to estimate survival and the population trend.

**Timing:** The first sampling period begins in June 2023.

**Who’s doing the research?** U.S. Fish and Wildlife Service (contact: Jennipher Cate); U.S. Geological Survey (contact: William Beatty)

Genetic data from biopsy samples are used to identify individuals and determine their sex.
**What is being studied?**

**Body condition of female walrus**

**Questions:** How does a female walrus’ body condition affect reproduction?

**What are the study methods?**

- **Part 1:** Hunters on St. Lawrence Island measure the girth and length of harvested walruses and their calves. They also collect biological samples that will be used to explain how changes in body condition affect reproduction.

- **Part 2:** Scientists are testing whether they can estimate walrus body conditions from images taken by unoccupied aerial vehicles (commonly called drones). The walruses in the study live at aquariums in the United States and Canada.

Combining the results from parts 1 and 2, biologists hope to develop a technique for monitoring changes in walrus body condition using images taken with drones. If successful, annual drone surveys would photograph walruses at land-based haul outs. From the photos scientists would determine body condition and possibly track calf survival.

Data from all projects will eventually be combined to improve estimates of survival, reproduction and abundance.

**Who’s doing the research?** U.S. Geological Survey (contact: Karyn Rode); Eskimo Walrus Commission; subsistence hunters on St. Lawrence Island; U.S. Fish and Wildlife Service

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*Photo by Grigory Tsidulko*
The Eastern Bering Sea is transitioning from an Arctic ecosystem to sub-Arctic conditions. Since 2014, extreme ocean heat resulted in a series of low-ice winters. Winter sea ice is needed to maintain the cold pool of bottom water that normally exists over the shelf. The reduced cold pool affected crab abundance in the Bering Sea, which was documented by the 2019 and 2021 bottom trawl surveys. These graphs compare the historic size of the cold pool (2010 map on far left) to recent years when bottom conditions were warmer. Maps from NOAA Fisheries.

### Snow crab abrupt collapse

**What did they observe?** During 2019–2021, the snow crab stock in the Eastern Bering Sea apparently collapsed. The stock had previously supported a fishery worth about $100–175 million annually (wholesale value), making it the most lucrative fishery for an Arctic species in the United States. The 2021 quota dropped 88% from the 2020 value, causing a major economic hit to stakeholders and communities.

**Snow crab biomass**

These graphs show the biomass of commercial snow crab stocks caught in the Eastern Bering Sea during the National Marine Fisheries Service bottom trawl survey, 1998–2021 (no surveys were conducted in 2020). This figure was adapted from the Eastern Bering Sea Ecosystem Status Report.

**What was the cause?** The immediate cause of the snow crab collapse is likely increased mortality related to the loss of suitably cold bottom waters, which are especially important for immature crab.

**What kind of research is happening?**

- Scientists are using climate models to estimate the probability that the Eastern Bering Sea will continue transitioning to sub-Arctic conditions. This knowledge will help stakeholders and fisheries managers adapt and plan for the future.

- A new lab, field and computer modeling study is looking at bitter crab disease, a fatal disease that is becoming more common for snow crab and may be an important link between ocean warming and mortality.

- The upcoming 2022 bottom trawl survey will help confirm the magnitude of the collapse.

**Who’s doing the research?** Shellfish Assessment Program at Alaska Fisheries Science Center, NOAA Fisheries (contact: Mike Litzow, Erin Fedewa, and Leah Zacher)
**Bristol Bay red king crab slow decline**

**What did they observe?** The closure of the Bristol Bay red king crab fishery during the 2021/22 season was an additional concern for Bering Sea crab fisheries. Rather than an abrupt collapse, this stock has been plagued by more than a decade of low production of young crab, which has caused the stock to gradually decline.

**Red king crabs in Bristol Bay**

These graphs compare the biomass of commercial red king crab stocks caught in Bristol Bay during the National Marine Fisheries Service bottom trawl survey from 1998–2021 (no surveys were conducted in 2020). This figure was adapted from the Eastern Bering Sea Ecosystem Status Report.

**What research is happening?** Lab studies of larval king and snow crab ecology and behavior may improve computer models that link crab productivity to ocean changes.

**Who's doing the research?** Shellfish Assessment Program at NOAA Alaska Fisheries Science Center, (contact: Mike Litzow, Erin Fedewa, and Leah Zacher)

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**Featured study**

**King crab movements**

**Question:** Where are red king crab found relative to closed areas and management boundaries? Large male red king crab are seldom harvested by the summer commercial fishery in Norton Sound — do they stay nearshore or migrate offshore beyond the commercial fishery?

**What were the study methods?** In June 2021, 92 satellite tags were placed on large male red king crabs (those with a carapace 120 mm or longer). The crab were tagged and released in Norton Sound near Sledge Island, Cape Nome and Golovin Bay. Of the tags set to “pop up” in early August, 27 successfully transmitted their locations. 57 of the tags scheduled for early October were successful.

**Timing:** A few test tags were placed on crabs in 2020; their success prompted the larger 2021 study.

**Who’s doing the research?** Alaska Department of Fish and Game (contact: Jenefer Bell); Norton Sound Economic Development Corporation

**Where did the crab go?**

Most of the tagged large red king crab moved west-southwest and their final locations aligned with commercial fishery tagging studies. This suggests that in spring large male crab in nearshore waters do not have a different migration pattern from other male red king crab, and are therefore available in the summer commercial fishery. Map by Jenefer Bell.

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![A pop-up satellite tag on a red king crab. Photo courtesy of Norton Sound Economic Development Corporation](image-url)
What is being studied?

**Halibut movements**

**Questions:** Where and when do halibut move throughout the Northern Bering Sea? Where do they spawn?

**What are the study methods?** Halibut were captured using longlining vessels near Nome and Savoonga. Pop-off satellite tags were attached to halibut near the dorsal fin. The tags recorded the water temperature, depth and light intensity experienced by the halibut.

The tags were preprogrammed to pop-off the halibut and float to the surface after 6-12 months. At the surface, they transmitted their data via satellite. These data were used to reconstruct the halibut’s movements and the space they occupied.

**Timing:** Began in 2019. The next round of tags will pop off in spring/summer 2022, and additional halibut will be tagged.

**Who’s doing the research?** Norton Sound Economic Development Corporation (contact: Dawn Wehde); UAF College of Fisheries and Ocean Sciences (contact: Austin Flanigan)


Where did the halibut go?
The 13 halibut tagged in the Northern Bering Sea migrated offshore to the continental slope. They typically left shallow foraging grounds in October and reached the slope in early January. They remained in deep waters through March, then began a return migration in April, reaching shallow summer foraging areas by July. **Map by Austin Flanigan.**
Before 2015, seabird die-offs in Alaska were rare and typically linked to disease or strong El Niño events. Since at least 2017, large die-offs in the northern Bering and southern Chukchi seas have been concurrent with massive ecological shifts, including a warmer ocean and less sea ice. Starvation has been identified as the main cause of death among seabird carcasses examined.

Seabirds may compete with species like Pacific cod and walleye pollock for food. The shrinking cold pool thermal barrier no longer restricts these fish species from entering the northern Bering Sea. Other possible factors contributing to the seabird die-offs include forage fish quantity and quality, and exposure to harmful algal bloom biotoxins.

Who’s tracking the die-offs? US Fish and Wildlife Service (contact: Robb Kaler); Alaska Department of Fish and Game; Alaska Migratory Bird Co-Management Council; Alaska Sea Grant; Aleutian Pribilof Islands Association; Aleut Community of St Paul Island, Tribal Government; Coastal Observation & Seabird Survey Team (contact: Jackie Lindsey); Kawerak Inc.; National Park Service; University of Alaska; US Geological Survey; many citizen scientists from Tribes and communities

Harmful algal bloom testing

Questions: One area of research is whether harmful algal blooms contribute to the seabird die-offs. In general, more phytoplankton means more food and oxygen in the ocean, but occasionally plankton blooms are hazardous to human or marine life. These are known as harmful algal blooms or HABs. They are an issue of growing concern in northern waters.

What are the study methods? Testing for harmful algal bloom toxins at seabird mortality events is ongoing in Alaska, including in the Bering Sea. Scientists are also studying how saxitoxin (which causes paralytic shellfish poisoning and is produced by some HAB species) impacts the behavior and physiology of seabirds.

What do the initial results show? Saxitoxin or domoic acid (which causes amnesic shellfish poisoning and is produced by some HAB species) were not detected in seabird carcasses collected in the Bering Sea during 2021, although fewer carcasses were submitted for analysis than in previous years. HAB toxins have previously been reported at potentially harmful levels in seabirds and marine mammals from the Bering Sea and Bering Strait regions.

Who’s doing the research? USGS Alaska Science Center (contact: Caroline Van Hemert)
CLIMATE & WEATHER HIGHLIGHTS

Winter 2020/2021 in the Bering Sea region was cooler than recent years. There was more and faster growing sea ice. Persistent storms mixed the ocean in summer which kept the temperatures cooler than in recent years.

Who's doing the research? Alaska Center for Climate Assessment and Policy (contact: Rick Thoman)

Read more ► www.facebook.com/groups/631657950559392

BERING SCIENCE DISCLAIMER

Though state and federal management agencies, Tribal and science organizations contributed information and results to this Bering Science report, it is not a part of an official management process. It is not comprehensive and does not take the place of official documents like the NOAA Ecosystem Status Reports.

Throughout this report we have done our best to provide a well-rounded, synthesized and easy to understand perspective on salmon, halibut, walrus, crab and seabirds in the Bering Sea Region. We also provide examples of research happening on each topic, though much more work is being done than can be covered in 12 pages.