BERING SCIENCE

Winter 2020/2021 — Communicating science in and around the Bering Sea

www.beringregionoceandata.org

Dennis Davis from Shishmaref captured this photo of a storm eroding the road to the community dump on November 6, 2020. See more pictures of climate change impacts in Shishmaref on Dennis's Instagram account @eskimofixer.

Bering Region Ocean Data Sharing Initiative

AOOS Alaska Ocean Observing System

International Arctic Research Center

UAF University of Alaska Fairbanks

NOAA

WELCOME

The Bering Sea is experiencing many changes. Loss of sea ice and record high ocean and air temperatures continue to impact wildlife and all aspects of life for coastal communities. The Bering Region Ocean Update project began in spring 2020, in part, to increase regional data sharing among federal, state, community and private sector partners. This is the third report. Read previous **updates** and learn how information is gathered and reviewed at **https://aoos.org/beringregion**. We provide a resource to state, federal, community and university partners to share recent observations with community members and other scientists and management agencies. **If you gather data or have observations of changes in the Aleutians, Bering Sea or southern Chukchi Sea contact us for possible inclusion in a future Bering Science report.**

COVID-19 impacts

2020 was a challenging year, due in large part to the COVID-19 pandemic. Normally, many different groups collect data on everything from salmon populations, to water chemistry, to seabird breeding success in the Bering Sea. These monitoring efforts provide critical data on the health of the Bering Sea ecosystem and allow us to track how it is changing.

In 2020, non-local scientists could not travel to rural communities because of COVID-19. Many surveys, including several NOAA research cruises, were canceled. US Fish and Wildlife Service was unable to conduct seabird research. Even so, information gaps were filled through collaboration with community and research partners and using new innovative technologies.

Ecosystem Status Reports

In this publication we share many findings originally compiled for the NOAA **Ecosystem Status Reports**. These yearly reports describe the status of the Alaska marine ecosystems. Along with fishery stock assessments, they are used by the North Pacific Fishery Management Council to inform commercial fishing quotas in federal water.

In recent years, Ecosystem Status Reports began including diverse types of information. Communities and Tribes now contribute local and traditional knowledge and help define new indicators of ecosystem health. With many NOAA research activities canceled in 2020, local-scale community observations were particularly critical to the reports as were the addition of satellite-derived indicators. **REPORT ecosystem observations in your community to the Ecosystem Status Report editors listed on page 16 or through regional channels.**

COMMUNITY ADVISORY BOARD

We thank our advisory board for providing direction, suggestions for content and feedback.

Chandra Poe, Qawalangin Tribe Of Unalaska

Connie Melovidov, Aleutian Pribilof Islands Association, Inc.

Erica Lujan, Alaska Native Tribal Health Consortium

Jennifer Hooper, Association of Village Council Presidents

Lauren Divine, Ecosystem Conservation Office at Aleut Community of St. Paul Island

Mellisa Johnson, Bering Sea Elders Group

NAVIGATION

Who are we?

This report is part of the Alaska's Changing Environment series (https://bit.ly/3fbkhAO). It was compiled by the Alaska Ocean Observing System and the International Arctic Research Center with collaboration from the National Oceanic and Atmospheric Administration.

Reviewers

Thank you to our reviewers who provided valuable input on this publication.

Cite this report

Prewitt, J. and H. R. McFarland, editors. Bering Science: Winter 2021 Bering region ocean update, Issue 3 [newsletter]. Alaska Ocean Observing System, Anchorage, Alaska.

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 https://www.surveymonkey.com/r/BeringScienceWinter21.

What do the orange circles mean? For each piece of information in this report we provide the data/information source and a person to contact to learn more. Use the number in the circle to locate the associated contact and source on page 16.

Meet Paul Melovidov from St. Paul Island.

ISLAND SENTINELS OF SAINT PAUL

Meet Aaron Lestenkof from St. Paul Island.

What is your job?

Paul Melovidov and Aaron Lestenkof are Indigenous Island Sentinels for the Aleut Community of St. Paul Tribal Government Ecosystem Conservation Office. "As Sentinels we're on the front lines, witnessing the changes in our environment," said Paul, Sentinel Coordinator. "With data collection we are able to better understand what's happening with our ecosystem." They contributed data to the Pribilof Islands seabird section on page 15.

What do Island Sentinels monitor?

As Island Sentinels, Paul and Aaron gather impressively diverse data on everything from seabirds, to reindeer to erosion. Their regular surveys of Steller sea lions, northern fur seals, harbor seals, sea ducks, gulls and reindeer help track population sizes and Indigenous harvest activities. They also highlight changes, like a recent shift in seabird behavior. "The seabirds that usually migrate when it gets cold this time of year, we're starting to see them stick around a little longer," said Aaron.

Monitoring beaches for stranded marine mammals and dead seabirds that might be an indication of mass die-offs is another important aspect of the Sentinels' work. On rookeries and marine mammal habitats they help organize semi-annual marine debris clean ups, which average about 20,000 pounds of debris per event. Their stewardship helps keep marine mammal rookeries and haul outs clear of plastics. Adjusting to the ever changing environment, the Sentinels also recently began testing for harmful algal blooms and are instrumental in preventing rats, which have decimated bird populations on some Aleutian Islands, from reaching the island.

What are the biggest changes you've seen recently?

According to Paul, climate change and over fishing have changed St. Paul Island over the past ten years. "You're looking at a decline in marine mammals, northern fur seals and Steller sea lion. You've got mass die-offs of migrating birds. Migrating birds not returning back to the island... Decline of halibut and crab in the Bering Sea... Sea ice normally would come down to the Pribilof Islands, now we're barely seeing sea ice come down to the islands at all. Less winter snow and more gale force wind storms through fall and winter months. Lastly, there is more marine debris on our beaches and shorelines." Many of these changes are impacting the entire Bering Sea region and Paul and Aaron emphasized that communities are not alone, they are in this together.

Learn more about Paul and Aaron's work on their Facebook Page www.facebook.com/EcoSysCon

Paul Melovidov and Aaron Lestenkof survey a beach for seabird carcasses. Photo by Hillary Burgess.

FISH BIOLOGIST

Meet Dr. Katie Howard from Anchorage. She contributed the salmon information on page 7 of this report.

What do you study?

I'm a fisheries scientist at the Alaska Department of Fish and Game. I study the marine life of salmon — trying to understand how these big questions around climate change, carrying capacity in the ocean and competition among species may influence Alaskan salmon and our fisheries, and how we can use this knowledge to inform decisions about our fisheries.

Why do you do the work you do?

Fish and fisheries are important to people. They represent food, livelihoods, a lifestyle and are integral to people's cultures. Growing up, I always wanted to use whatever skills and talents I had to help people — being a fisheries scientist who can discover and share information that helps people make decisions about their fisheries is how I've found I can do that. Fish and the natural world are also amazing, which makes it easy to be passionate about my work.

What is the most rewarding/interesting thing about your work?

There is so much that is interesting about salmon in the Bering Sea, I wouldn't even know where to start! Easily the most rewarding thing about my work is the people. I am very fortunate that I get to work with and interact with incredible scientists, fishermen, stakeholders, boat crews, students and communities almost every day. I learn something new every time, and I've met some truly inspiring people along the way.

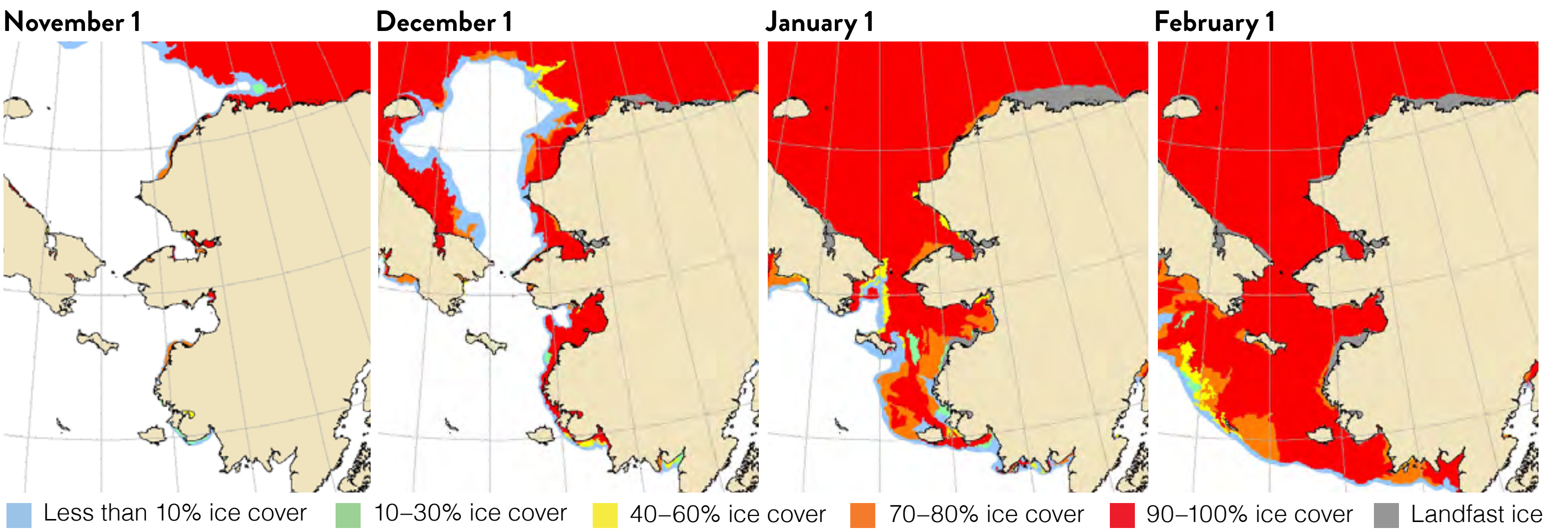
Is there anything else you would like to add?

Learn more about salmon in the ocean, share ideas, insights, or get information – check out our Facebook page www.facebook.com/ADFGUnderseaWorldOfSalmonAndSharks

CLIMATE UPDATE

SEA ICE EXTENT 1

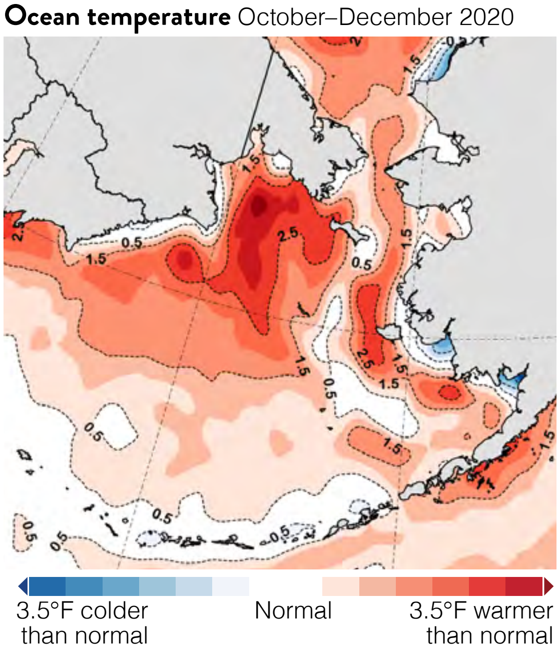
Sea ice development was characteristically slow this autumn. Ice did not cover the Chukchi Sea until mid-December, which is not unusual in recent years, but is nearly a month later than was typical prior to 1990. Bering Sea ice extent for November was the lowest since 1978, and Nome had open water until the second week in December. Ice cover increased after mid-December. By the start of February, the ice extent was only about 15 percent below the long-term average but much of the ice was still quite thin.



OCEAN TEMPERATURE 2

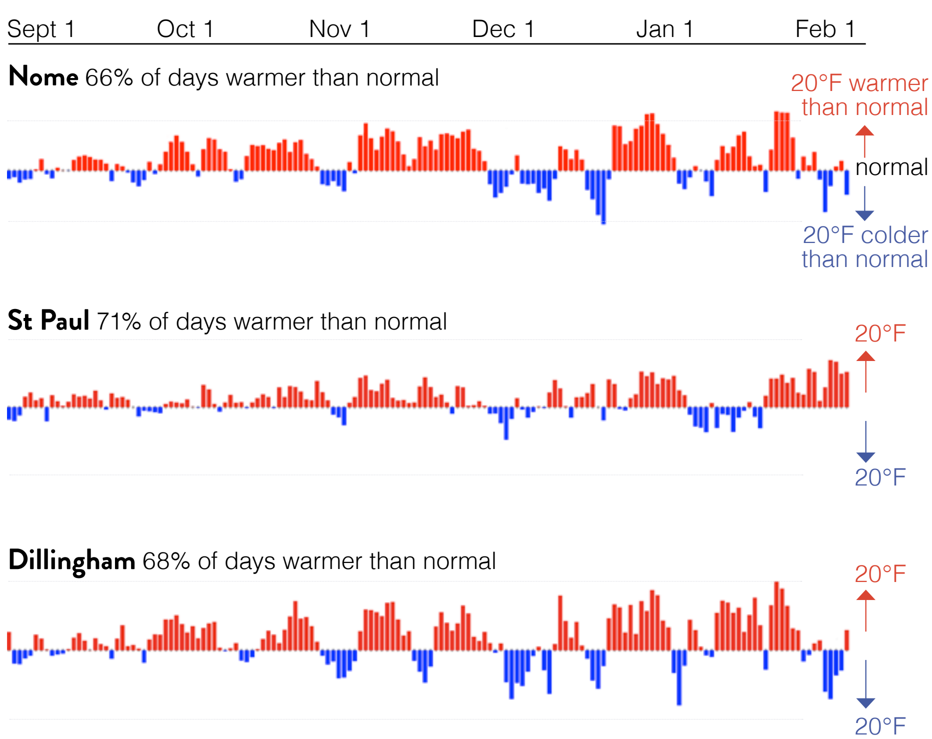
Ocean temperatures were not as warm as the same time in 2019–2020 but were still well above normal in most areas. Some areas by Shishmaref, Dillingham and the mouth of the Kuskokwim River were all slightly colder than normal. As sea ice developed after January 2021, ocean temperatures beyond the ice edge were near normal, though some areas offshore of the Russian coast remained warmer than normal.

Ocean temperature October–December 2020



AIR TEMPERATURE 3

Air temperatures were above normal in most areas every month from September 2020 to January 2021, and two-thirds or more of days were warmer than normal. The warmth was especially notable in the northern Bering Sea, where Nome had the 5th mildest autumn (September through November) in more than 110 years of observations. While a greater percentage of days were warmer than normal on St. Paul, 2020 was not even in the top 10 warmest autumns.

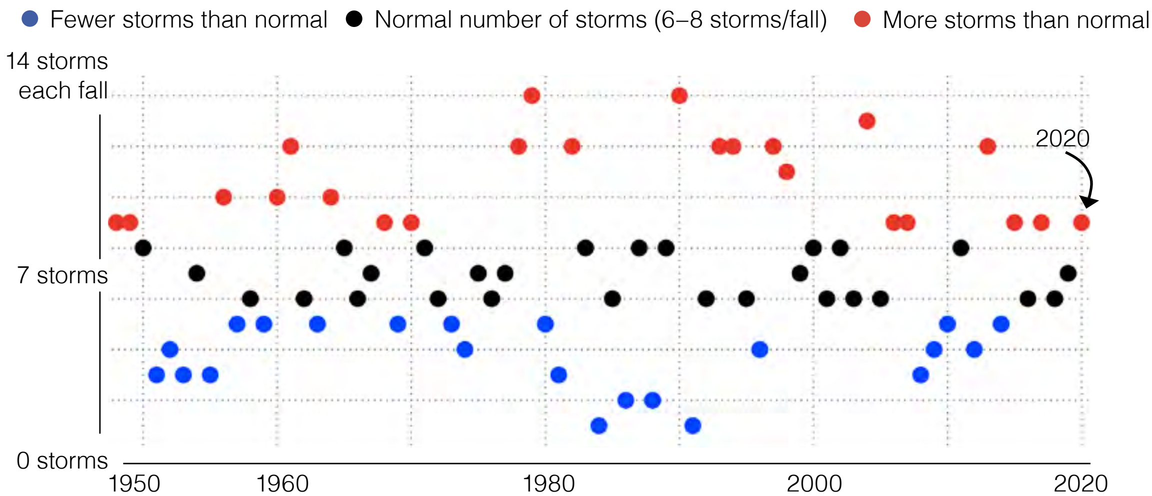


FALL STORMS

Historically, sea ice buffered Chukchi and Bering sea communities from potential damage during winter storms. As ice disappears, high wind events pose more threat of coastal flooding and erosion. These impacts could increase in the future according to a recent study by the University of Alaska Fairbanks. By 2099, winds along the coast from Utqiaġvik to Nome are projected to grow stronger. 4

NUMBER OF STORMS 5

The graph to the right shows the number of fall (September to November) storms in the Bering & Chukchi seas. 2020 had nine fall storms that were potentially strong enough to produce coastal flooding somewhere on the Alaska coast. This is slightly more storms than the region normally experiences during that period.



FALL WINDS 6

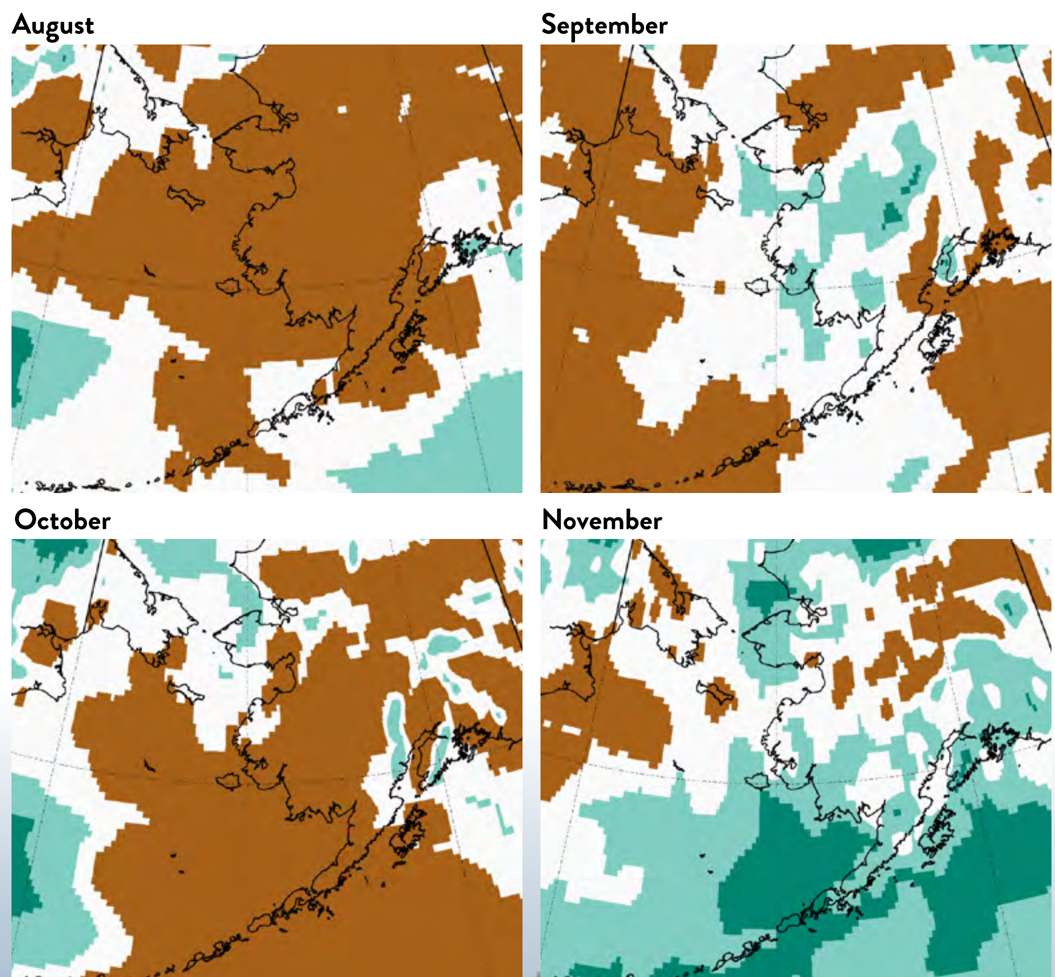
These four maps compare the wind speeds over Alaska from August to November 2020 to the 1981–2010 average. Throughout much of the Bering Sea there was less wind or near average wind in August and October. In November, typically a time of intense storm activity, most of the Bering Sea was windier than normal.

Below average wind

Near average

Above average

Much above average



Coastal flooding after a storm on Shishmaref.
Photo by Dennis Davis, @eskimofixer.

EROSION & FLOODS

Many Alaska coastal communities are vulnerable to erosion, flooding and permafrost degradation. To help communities plan and communicate with state and federal agencies, the State of Alaska recently summarized the long-term shoreline change in 48 northern and western Alaska communities. 57 percent of the communities had erosion rates greater than 3.3 feet per year over the past 60 years.

Regional processes

Below are examples of how the type of shoreline common in different regions of the Bering Sea influences erosion and flooding of coastal communities.

Bering Strait: Many coastal communities are built on mixed sand, gravel spits and barrier islands. This makes them vulnerable to storm surges and flooding, as well as erosion.

Yukon-Kuskokwim Delta: Coastal flooding can reach 20 miles inland to communities that are built along extremely low lying, coastal and tidally influenced rivers.

Bristol Bay & Alaska Peninsula: Most communities are perched on 20 foot or higher bluffs. The tall and exposed nature of the bluffs makes them vulnerable to groundwater seepage and overland runoff. Waves can erode the base of the bluffs, destabilizing them and causing slumps. On the Alaska Peninsula, the coastline is predominantly covered by volcanic materials, like pumice-rich bluffs that are easily eroded.

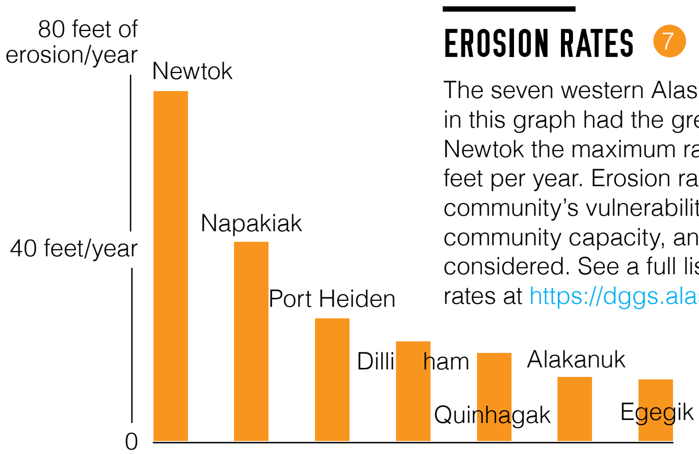
REPORT storms that flood or cause erosion near your community to the Alaska Water Level Watch Facebook page https://bit.ly/3jmSdL6.

2020 STORM IMPACTS 8

The 11 communities on this map with color dots saw erosion and/or flooding in fall 2020. Dot color shows which storms impacted each community. Communities without a dot are shown because they are mentioned in the graph at the bottom of the page.

EROSION RATES 7

The seven western Alaska coastal communities in this graph had the greatest erosion rates. In Newtok the maximum rate of erosion was 72.8 feet per year. Erosion rates alone do not define a community's vulnerability. Infrastructure location, community capacity, and other factors must be considered. See a full list of community erosion rates at https://dggs.alaska.gov/pubs/id/30552.

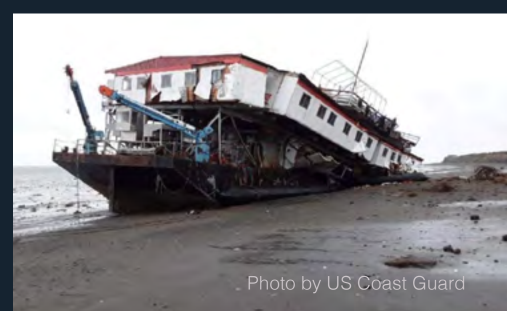


EROSION IN GOLOVIN

Toby Anungazuk Jr. shared this photo with the Dept. of Natural Resources showing coastal erosion near Golovin after a November storm.

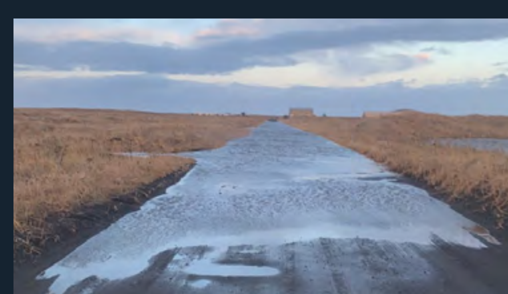
EROSION IN HOOPER BAY

William Naneng shared this photo with the Dept. of Natural Resources of a coastal bluff eroding near Hooper Bay after a November storm.



HIGH WINDS IN EKUK

A seafood industry barge broke anchor and beached near Ekuk after the August 30 storm hit the area with 80 mph winds. Nearby at Naknek, water levels measured five feet above the highest hide tides.



FLOODING IN NELSON LAGOON

Angela Johnson shared this photo with the Dept. of Natural Resources of flooding after a storm on November 20 near Nelson Lagoon.

SALMON [9]

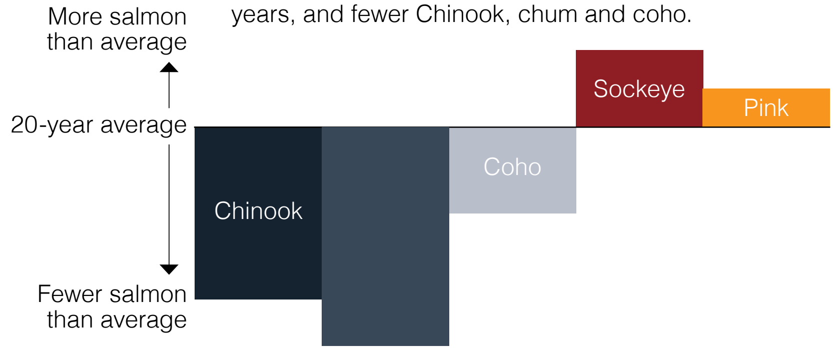
CHINOOK, CHUM, COHO

In 2020, salmon abundance throughout Alaska was lower than average for most species and stocks. Chinook salmon runs have generally been below average to poor since 2008 across the entire state including western Alaska, and 2020 was no exception. Yukon River Chinook salmon stocks are expected to continue to decline in 2021 and 2022.

Many chum salmon runs in western Alaska were near average to strong over the past decade, but 2020 runs were consistently poor across all stocks. Similarly, coho salmon stocks tended to be fairly strong from about 2014–2018 in western Alaska, but were near average to poor in 2020.

2020 SPECIES OVERVIEW [9]

The graph below shows which salmon species had lower or higher abundance in the Bering Sea during 2020. There were more sockeye and pink than the past 20 years, and fewer Chinook, chum and coho.

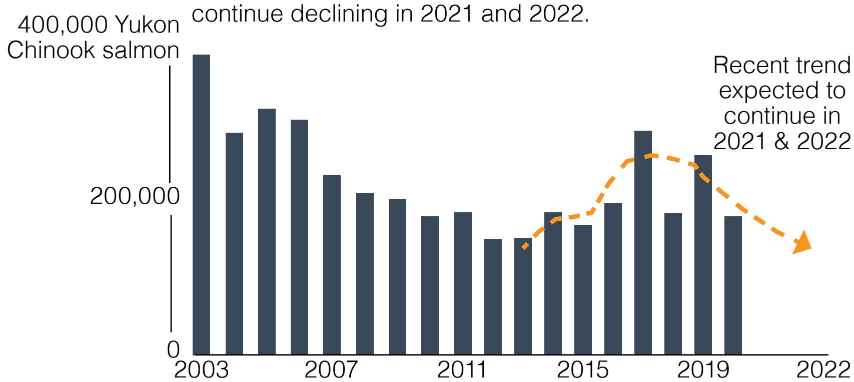


SOCKEYE AND PINKS

One of the few bright spots for salmon abundance in the state is the continued strong sockeye salmon run sizes for most, but not all, western Alaska stocks. This trend has been occurring since about 2015. Pink salmon abundance in western Alaskan was also high in 2020. Odd and even year pink salmon abundance has been very strong in the region since about 2016.

YUKON RIVER CHINOOK RUN SIZE [10]

The graph below shows the number of Chinook salmon in the Yukon River run since 2003. The abundance of Yukon River juvenile Chinook salmon in the northern Bering Sea has decreased since 2017. Based on this, the Yukon River Chinook salmon run size is expected to continue declining in 2021 and 2022.



Advancements despite COVID-19

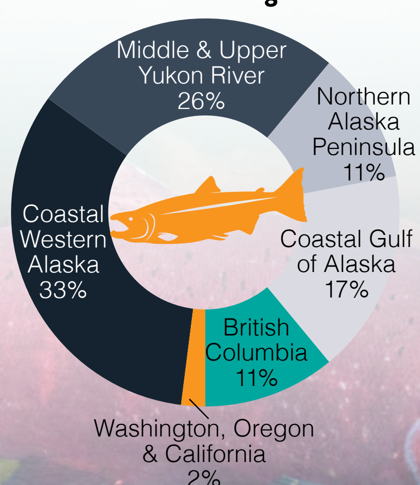
Alaska Department of Fish and Game and NOAA Alaska Fisheries Science Center were unable to survey in the northern Bering Sea in 2020 due to COVID-19. Even so, several new analyses furthered our understanding of salmon ecology in the region. While juvenile Chinook salmon in the Bering Sea are from western Alaska, biologists have learned where immature (1+ years at sea) Chinook salmon originated by analyzing genetic samples taken during fall Bering Sea surveys from 2003–2019. This new information on immature Chinook migratory patterns is critical to understanding ecological processes that impact Chinook stocks.

WHERE DO CHINOOK COME FROM? [9]

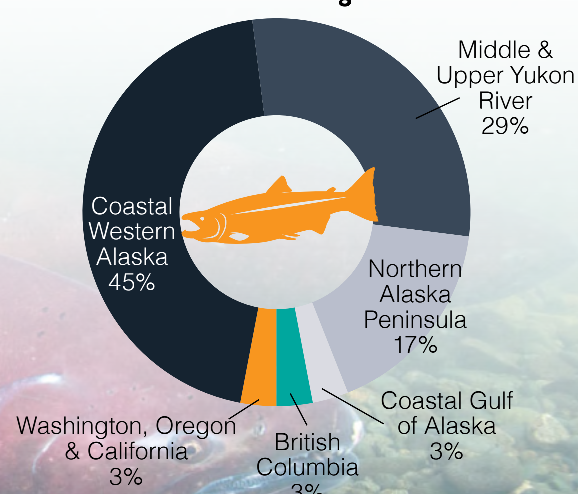
91% of the immature Chinook salmon in the northern Bering Sea come from western Alaska rivers, including the Yukon River. In the southern Bering Sea, these stocks make up 70% of the immature Chinook salmon caught, with Gulf of Alaska, British Columbia, and Pacific Northwest stocks comprising the remaining 30%.

Graphics adapted from Alaska Department of Fish & Game

Southern Bering Sea



Northern Bering Sea



Chinook salmon. Photo by UW FWS.

WALLEYE POLLOCK

POLLOCK & THE COLD POOL [11]

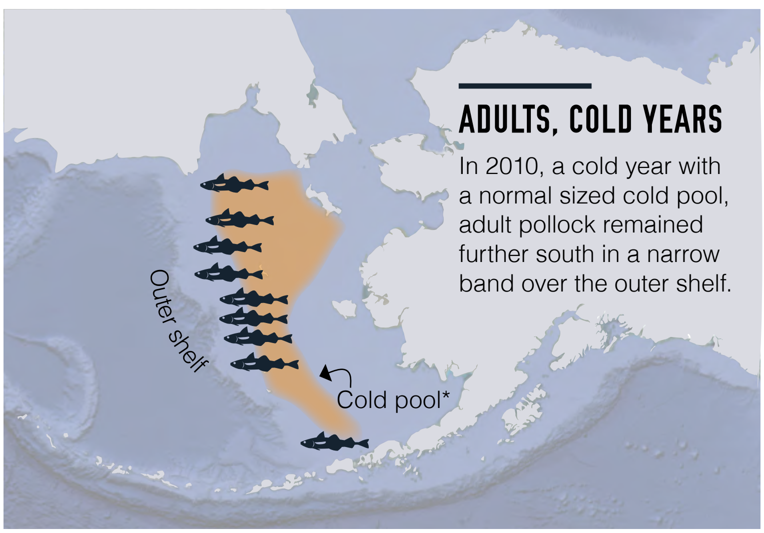
The eastern Bering Sea "cold pool" is about a 100-foot layer of water that forms near the ocean floor in areas where thicker sea ice remains late into spring. Water temperatures in the cold pool are usually 28.5–35°F. Since adult pollock rarely venture into water colder than 32°F, the cold pool historically created a natural barrier keeping them from moving northward.

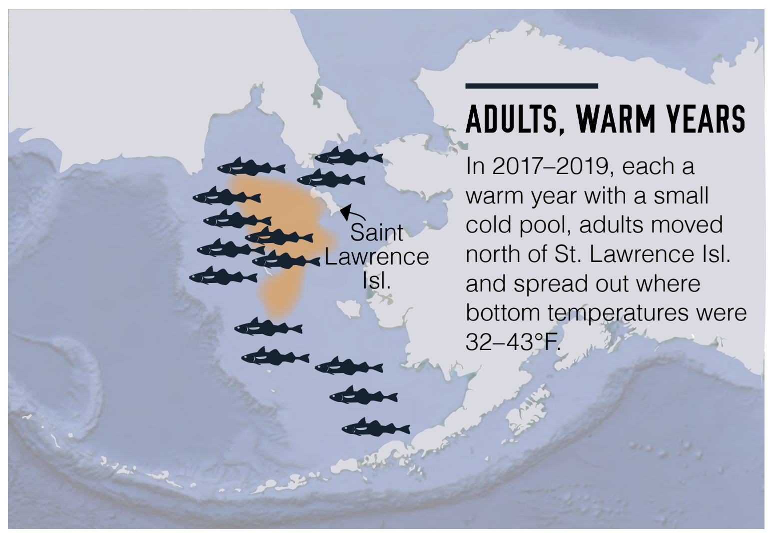
The cold pool was the smallest ever recorded in 2018 and 2019. In both years there were strong north/northwestward bottom currents over the region. These currents affected the distribution of both adult and age-1 pollock.

New research confirms that the shrinking cold pool allows for increased mixing of the Russian and U.S. populations of pollock. The Russian population is moving north and eastward, and the U.S. population is moving north and westward.

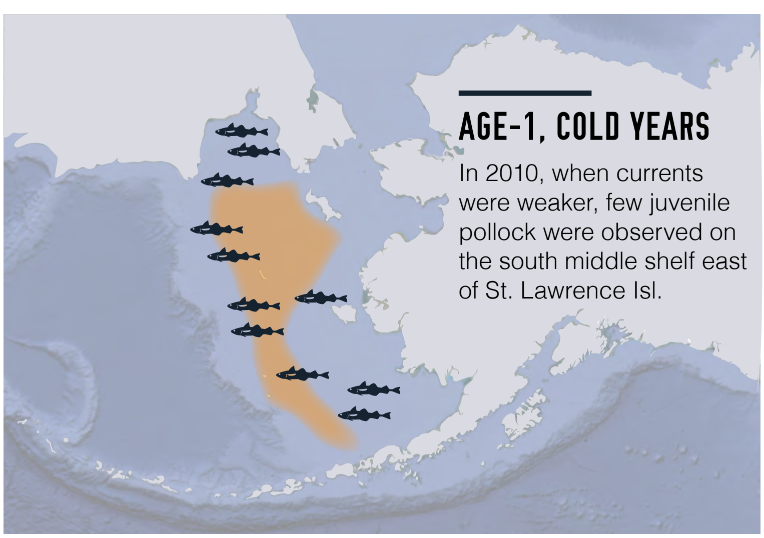
In 2018 and 2019, NOAA surveys found high densities of juvenile pollock in the southern Chukchi Sea, in both the U.S. and Russian sectors. Russian scientists also observed high densities of adults. This suggests that pollock can move northward into the Chukchi Sea as the ocean warms and sea ice diminishes. Whether it will be possible for pollock to colonize these northward regions, will depend on their temperature tolerance, water temperatures, prey resources, reproductive requirements and predation pressure.

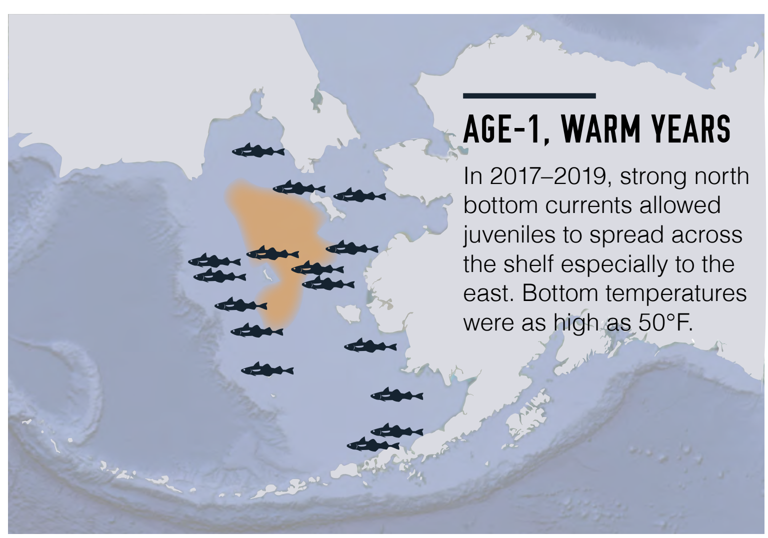
As these changes continue, collaboration between Russian and U.S. scientists is key to tracking changes in pollock movements across the entire Bering Sea shelf.





Rough outline of cold pool location in years mentioned.





Graphics adapted from NOAA Alaska Fisheries Science Center

CRAB

SNOW CRAB & THE COLD POOL (12)

Snow crabs need cold water, but how cold depends on the crab's life stage. Immature snow crabs live in cooler waters; as they mature, they migrate to slightly warmer habitat. Juvenile snow crabs are associated with the eastern Bering Sea's cold pool (described on page 8). This cold pool provides a thermal barrier protecting snow crab from major groundfish predators. Historically, immature snow crab dominated catches in the colder northern Bering Sea and commercial-sized (greater than 3.9 inches) males were rare.

The last NOAA snow crab surveys were conducted in 2019. During that summer, the cold pool was smaller and water temperatures were much warmer than juvenile snow crabs prefer, but they did not appear to relocate in search of colder habitats. These warm temperatures may have affected juvenile survival.

With less available cold water habitat, juvenile snow crab numbers dropped substantially across their range. As the barrier of the cold pool shrank, major crab predators like Pacific cod moved northward potentially gaining access to juvenile crabs.

Large snow crab

Unlike past years, in 2019, snow crabs caught in the northern Bering Sea included a substantial number of large crabs — including a 2000% increase in large males from 2018 to 2019. The origin of these large males remains unclear, though may indicate that the adult male segment of the population is moving north. These findings have important management implications and could suggest the potential for a commercial snow crab fishery in more northern latitudes.

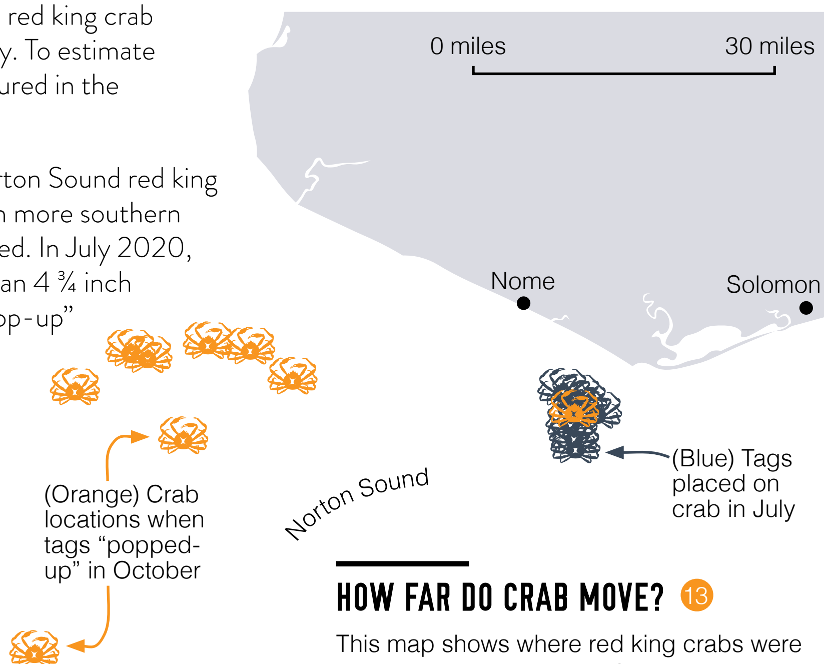
NOAA continues to monitor and study snow crabs to understand how vulnerable they are to climate change.

Snow crab. Photo by Erin Fedewa - NOAA.

NORTON SOUND RED KING CRAB (13)

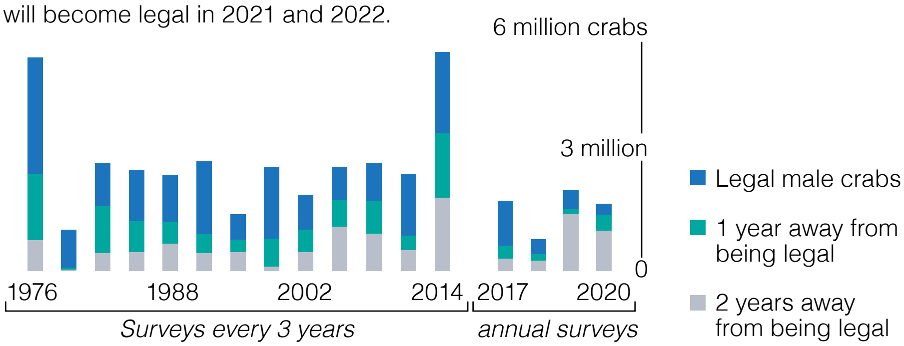
Alaska Department of Fish and Game (ADF&G) monitors the red king crab population in Norton Sound with an annual bottom trawl survey. To estimate the population size, they extrapolate the number of crabs captured in the survey across the total available habitat in Norton Sound.

ADF&G recently began a small pilot study to determine if Norton Sound red king crab, which are smaller (max ~5.7 inches carapace length) than more southern populations (max ~7 inches), could be effectively satellite tagged. In July 2020, biologists placed tags on 16 legal male red king crab (greater than 4 ¾ inch carapace width) near Nome. The tags were programmed to "pop-up" on October 6 and 7, 2020. Once reaching the surface they transmitted their pop-up locations as well as temperature and depth data, which were recorded hourly while on the crab.



CRAB POPULATION COMPOSITION (13)

The graph below shows the number of male red king crabs in Norton Sound based on ADF&G's bottom trawl surveys. In 2020, there were 227,854 legal male crabs (blue section of bars). While this is a potential low, biologists are encouraged by the high number of sublegal crab (turquoise and grey) that will become legal in 2021 and 2022.



HOW FAR DO CRAB MOVE? (13)

This map shows where red king crabs were satellite tagged in Norton Sound compared to where their tags "popped-up." Eight of the 16 crabs tagged carried very accurate, usable data. After being tagged the crabs generally moved west-southwest. They experienced temperatures ranging from 32.9–48.2°F and were consistently in waters 62–128 feet deep. A larger study is planned for summer 2021.

OCEAN ACIDIFICATION

WHAT IS OA? [14]

Cars, factories and other human activities release carbon dioxide into the atmosphere. About ¼ of this carbon dioxide is absorbed by the ocean, where it reacts with seawater in a process called ocean acidification. Alaska's waters are already naturally rich in carbon dioxide (because cold water holds more carbon dioxide than warm water) compared to many other regions of the globe. This means that it only takes a little added carbon dioxide to create water conditions that are less favorable to shell-building marine animals such as crabs, and can cause stress to other marine animals. Because of this, the Bering Sea is vulnerable to ocean acidification.

Patterns in the Bering Sea

Scientists use a combination of water samples and computer modeling to explore how ocean chemistry changes seasonally and from year to year. Samples gathered by ships have previously identified hotspots in the Bering Sea that are already corrosive with respect to some minerals that marine organisms use to build their shells. The bottom waters of deeper regions like the middle and outer shelves are relatively more acidic, while bottom waters in shallower nearshore areas are relatively less acidic.

Scientists are now developing a way to forecast how acidic Bering Sea conditions will be over the coming 4–5 months. These experimental forecasts will be made each spring for late summer water conditions and compared to observed ship-based water samples collected every other year.

Learn more about Ocean Acidification at https://aoos.org/alaska-ocean-acidification-network/.

CASE STUDY: BRISTOL BAY RED KING CRAB [15]

Ocean acidification and climate change are expected to stress Bering Sea king crab fisheries within the next few decades. A new study evaluated whether Bristol Bay red king crab already show signs of environmental stress. Scientists compared adult crab movements with modeled ocean acidification and temperature from 2003-2012.

Normally, crab move to avoid cool temperatures, and this study explored whether they also move based on ocean acidification. Scientists found that temperature and ocean acidification often change together (cold water tends to be more acidic), making it hard to see if ocean acidification impacts crab movements. It is good news that ocean acidification did not separately influence crab behavior. This means that red king crab have some protection against current ocean acidification levels. Since crab prefer warmer waters, they naturally avoid the most corrosive conditions.

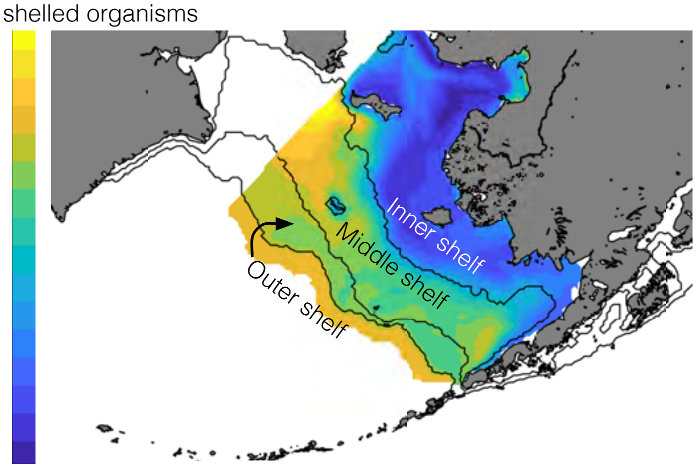
Larval and juvenile red king crab are more sensitive to acidified waters and are less mobile than adults. For now, scientists don't know whether young red king crab can avoid unfavorable conditions or adapt to changing ocean chemistry. More research is needed to understand the true extent that red king crab are resilient to ocean acidification.

Red King Crab. Photo by NOAA

NORMAL OCEAN ACIDIFICATION PATTERN [14]

This map shows modeled ocean acidification conditions from 2003–2019 in July to September. There is usually more corrosive (yellow on map) bottom water in the middle and outer shelf of the Bering Sea, and less corrosive water along the shallower, inner shelf closer to Alaska's coastline (blue).

More corrosive for shelled organisms

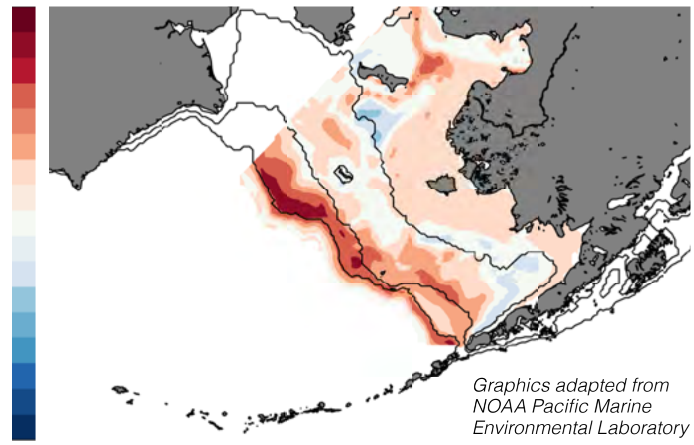


Less corrosive to shelled organisms

OCEAN ACIDIFICATION IN 2020 [14]

This map shows how different 2020 was compared to the 2003–2019 average (left map). In the 2020 map, the dark red on the outer Bering Sea shelf means conditions were more corrosive than normal. Few areas were less corrosive than normal (blue).

More corrosive than 2003–2019



Less corrosive than 2003–2019

Graphics adapted from NOAA Pacific Marine Environmental Laboratory

PLANKTON

MARINE FOOD WEB

Phytoplankton are the base of the marine food web. Like plants on land, phytoplankton use chlorophyll to carry out photosynthesis, capturing sunlight and carbon dioxide to produce energy.

Phytoplankton feed zooplankton, like the tiny copepod in this photo. Zooplankton feed the rest of the food web.

A copepod (zooplankton) species found in Bering Sea. Photo by Russell Hopcroft.

PHYTOPLANKTON [18]

There was less chlorophyll, indicating lower biomass of phytoplankton, in most of the eastern Bering Sea during 2020 than in 2019. Satellite data suggest that chlorophyll has been below average since at least 2016 over the southeastern shelf, except on the outer continental shelf where it was above average in 2020. Low chlorophyll could mean the Bering Sea was less productive and/or there was more grazing by zooplankton.

When conditions are right, phytoplankton populations can grow explosively, a phenomenon known as a bloom. The timing of the 2020 peak spring bloom over the southern shelf was about a week earlier than average.

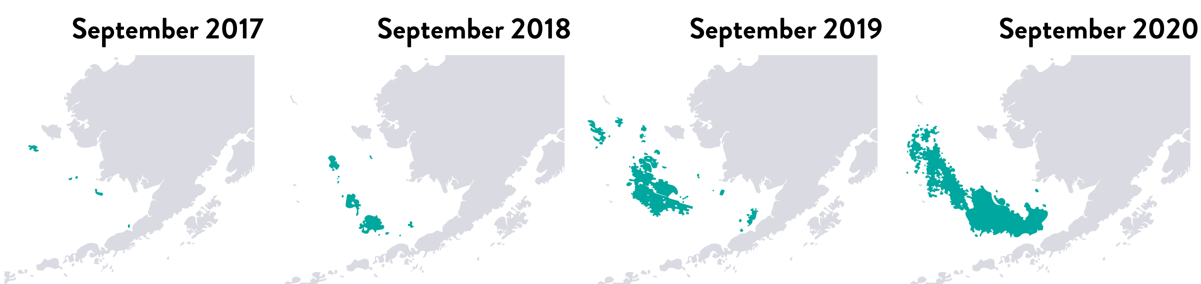
Coccolithophores are a type of phytoplankton covered in calcium carbonate (chalk). 2020's coccolithophore bloom over the middle shelf was much larger than in recent years. This type of bloom clouds the water, making it difficult for visual predators like fish and seabirds to find food. The small size of coccolithophores may also make them a less desirable food item for zooplankton.

Combined, these indicators suggest that the prey base in the eastern Bering Sea during 2020 was limited and/or poor quality. As a result there may have been less energy available to juvenile fish, seabirds and other marine organisms.

COCCOLITHOPHORES [19]

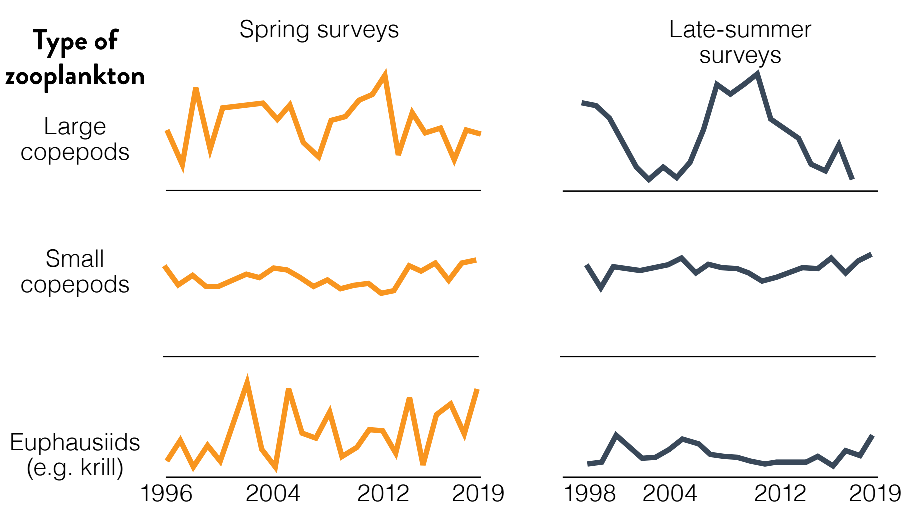
The maps to the right show the coccolithophore bloom over the middle Bering Sea shelf from 2017–2020.

Graphics adapted from NOAA Pacific Environmental Laboratory



ZOOPLANKTON [20]

Phytoplankton and zooplankton make up the most biomass in the ocean and play a necessary role in providing energy to other marine organisms. Monitoring zooplankton provides an important indicator to evaluate the health of the Bering Sea and detect changes in the ecosystem. Zooplankton surveys over the southern Bering Sea shelf have been conducted each spring since 1996, and each late-summer since 1998.



ZOOPLANKTON SURVEY TRENDS [20]

Large copepods vary considerably from year-to-year, especially in late summer. Small copepods do not vary as much. Euphausiids (e.g. krill) are more abundant and vary more in spring than in late-summer when their abundance is very low. This low euphausiid abundance in summer might be because they have become adults and are good at avoiding sampling gear.

Only large copepods in late summer appeared to correspond to "warm" or "cold" periods.

Graphics adapted from NOAA Alaska Fisheries Science Center

HARMFUL ALGAL BLOOMS

WHAT ARE HABS? [16]

In general, more phytoplankton means more food and oxygen for everything else in the ocean, but occasionally plankton blooms are hazardous to human or marine life. These are known as harmful algal blooms or HABs. As waters warm throughout Alaska, HAB events may increase in frequency and geographic extent.

Although many research cruises scheduled for 2020 were canceled due to COVID-19, offshore sampling for HABs was conducted during three cruises. Samples collected during these cruises will be analyzed for the presence of the two most common and impactful types of algae:

1. *Alexandrium* — can produce saxitoxins which cause paralytic shellfish poisoning that affects humans and animals.
2. *Pseudo-nitzschia* — can produce the neurotoxin domoic acid which causes amnesic shellfish poisoning that affects humans and animals.

HAB coordination

Monitoring and adaptation can reduce human and wildlife health risks associated with HABs. Over the past five years, regional programs have expanded. Tribal, agency and university entities now provide HAB testing and help alert shellfish harvesters and researchers of potential blooms to reduce human health risk.

All of these entities are partners in the Alaska Harmful Algal Bloom Network which was formed in 2017 to provide a statewide approach to HAB awareness, research, monitoring and response in Alaska.

See current alerts and learn more about harmful algal blooms at http://aoos.org/alaska-hab-network/.

2020 SAMPLE LOCATIONS [17]

This color-coded map shows where HAB events occurred or ships gathered samples in 2020.

September
NOAA personnel on the vessel *Oscar Dyson* collected surface and underwater HAB samples in the Bering Sea.

October
Maryland Center for Environmental Science aboard the *R/V Norseman II* collected sediment plugs to look for *Alexandrium catenella* at 29 stations.

Mid-October
Woods Hole Oceanographic Institute aboard *R/V Sikuliaq* collected HAB samples while sailing north to the Chukchi and Beaufort Seas, they also gathered water samples in the Bering Strait. Few *Alexandrium* were observed that late in the season, but *Pseudo-nitzschia* was found even under the sea ice in the Beaufort Sea.

Graphic adapted from Woods Hole Oceanographic Institute

[16] **Animals** – In the northern Bering Sea and Bering Strait, samples were collected from more than 70 animals including marine mammals, fish, clams, birds, and krill. Results are not yet available.

Summer 2020 – Aleut Community of St Paul Tribal Government Ecosystem Conservation Office began sampling limpets and water for HABs on Saint Paul Island.

[16] **September** – A high toxicity HABs event along Russia's Kamchatka Peninsula caused a major die off of octopus, seals, and other animals. People surfing and/or swimming in the area experienced sickness and corneal (eye) burns.

July 2020 – In Unalaska, [16] consumption of blue mussels and snails resulted in a fatality. A sample of the blue mussels in the area was 140 times the regulatory limit, while the snails were 3 times the limit.

[16] **Summer 2020** – High toxicity HAB events occurred at both ends of the Aleutian archipelago causing unprecedented levels of paralytic shellfish toxins in shellfish. Weekly shellfish samples were taken in 17 locations throughout the Aleutian and Alaska Peninsula region, results are being analyzed.

GRAY WHALES

UNUSUAL MORTALITY EVENT 21

The gray whale unusual mortality event (UME) declared in 2019 continued. In 2020, fewer strandings were reported in the Chukchi Sea possibly because COVID-19 precautions prevented aerial surveys of Arctic marine mammals. In 2019, the aerial surveys found eight of the 48 Alaska stranding. The geographic isolation of carcasses and decreased response capability due to COVID-19 also prevented any necropsies in Alaska during 2020.

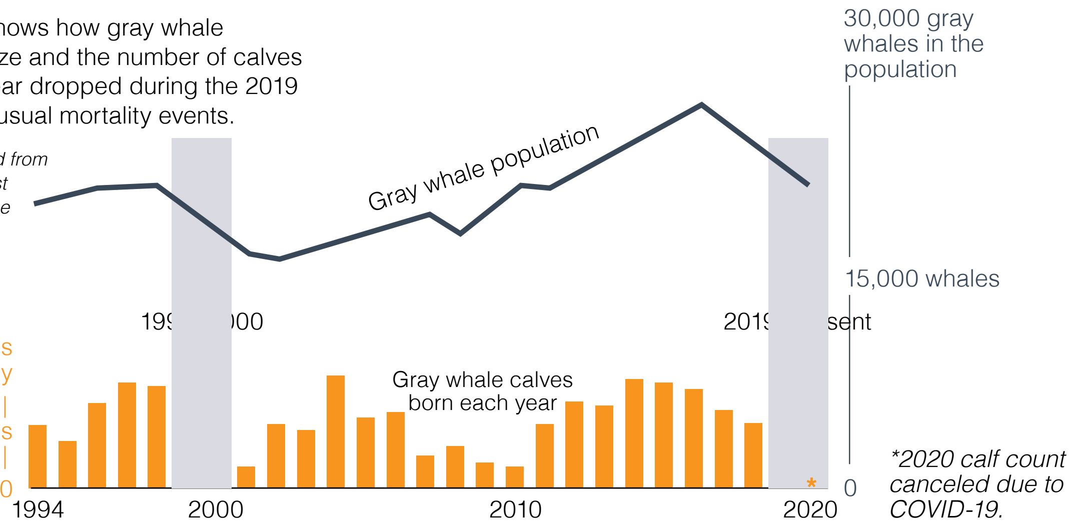
Population decline

The population of gray whales that migrates from Alaska to Mexico has declined about 24 percent since 2016. A similar 23 percent decline occurred after an unusual mortality event 20 years ago, from 1999–2000. The gray whale population rebounded following that previous UME to greater numbers than before. These large-scale fluctuations are not rare. The declines represent short-term events that, in the past, have not significantly impacted the long-term population status.

POPULATION SIZE 22

This graph shows how gray whale population size and the number of calves born each year dropped during the 2019 and 1999 unusual mortality events.

Graphic adapted from NOAA Southwest Fisheries Science Center



**2020 calf count canceled due to COVID-19.*

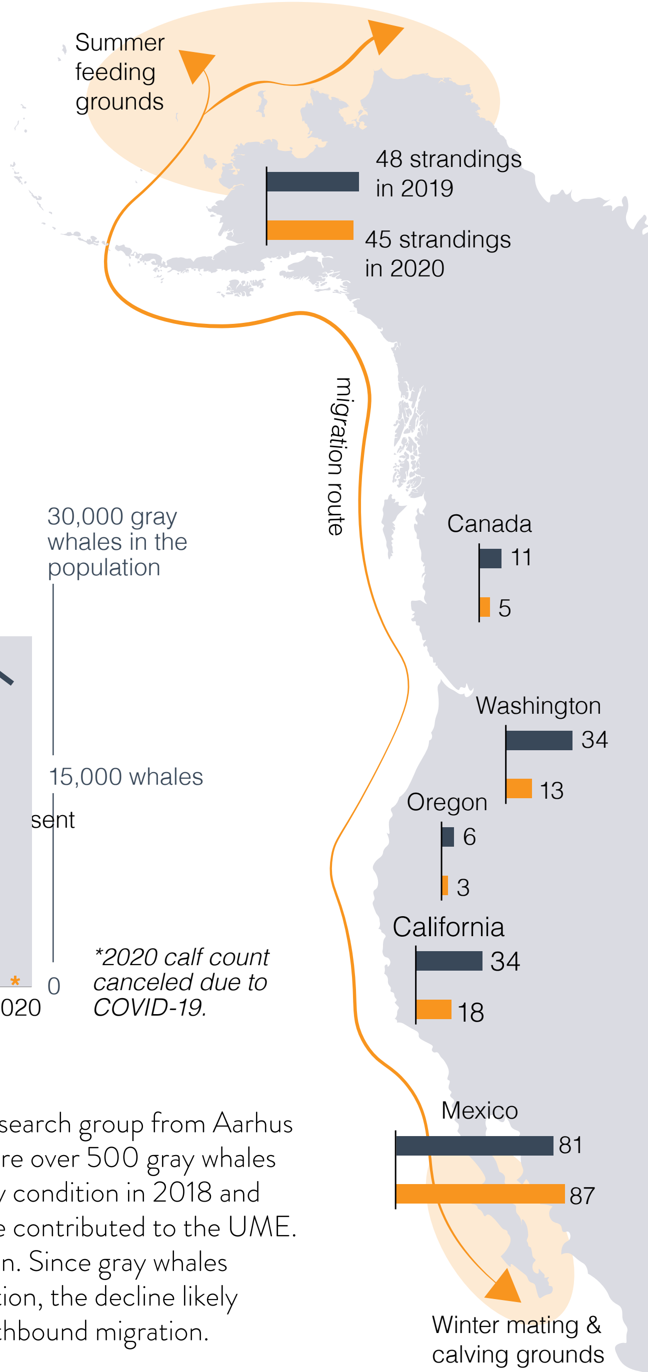
Poor body condition

The cause of the UME is still under investigation, however, a new study 23 by a research group from Aarhus University used Unoccupied Aerial Vehicles (aka drones) to photograph and measure over 500 gray whales on their wintering grounds in Mexico. Calves, juveniles and adults all had lower body condition in 2018 and 2019 compared to 2017. The study suggests that poor feeding conditions may have contributed to the UME. The underlying factors that caused this reduction in body condition are still unknown. Since gray whales in 2018 and 2019 arrived on their Mexican breeding grounds already in poor condition, the decline likely occurred either during the previous feeding season in Alaska and/or during the southbound migration.

STRANDING LOCATIONS 21

From 2019–2020, 388 gray whales stranded along their 12,500 mile migration route from Alaska to Mexico. Fifty fewer strandings were reported in 2020 (orange bars on map) compared to 2019 (blue bars on map) in the US and Canada. Strandings increased slightly in Mexico.

Graphic adapted from NOAA Fisheries Alaska Region



A gray whale mother and calf. Photo by NOAA.

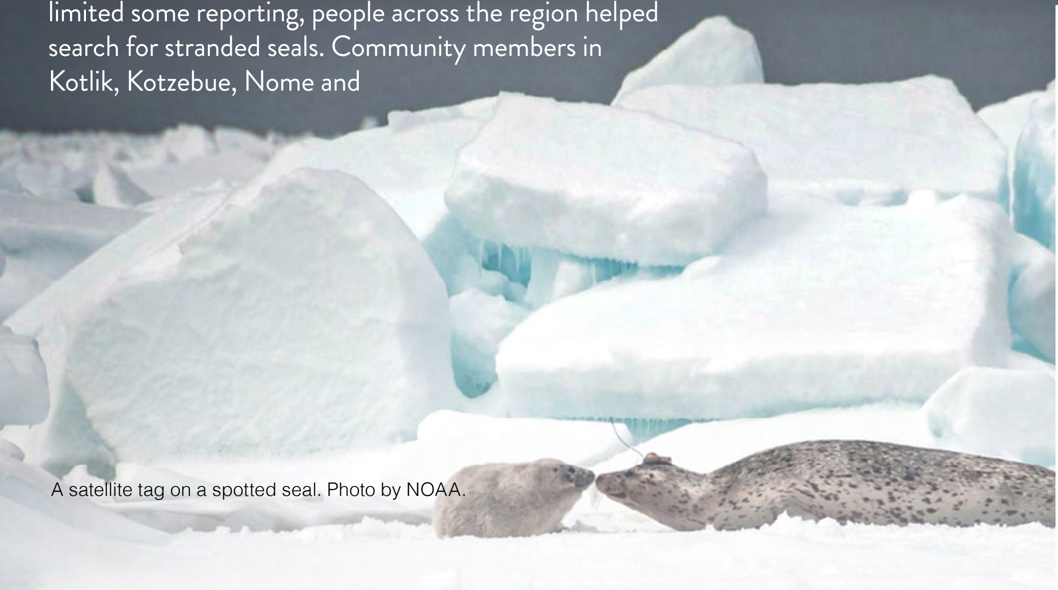
REPORT dead, injured or stranded marine mammals to NOAA's stranding hotline (877-925-7773) or through regional channels like Alaska Sea Grant (907-434-1149).

ICE SEALS [24]

Since June 2018, elevated numbers of bearded, ringed and spotted seals have washed up dead along the Bering and Chukchi coasts. NOAA classified the strandings as an Unusual Mortality Event.

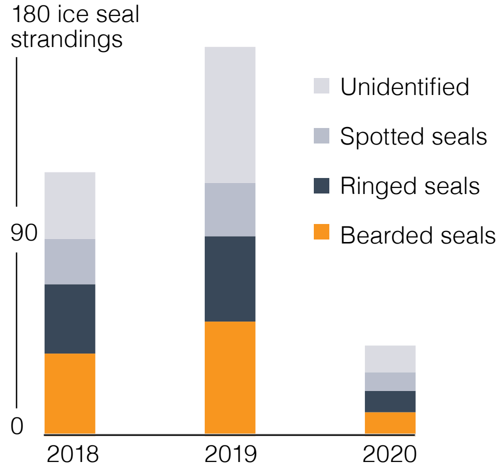
In 2020, the number of reported strandings returned to a more 'typical' number of ice seals. Although COVID-19 may have limited some reporting, people across the region helped search for stranded seals. Community members in Kotlik, Kotzebue, Nome and Stebbins surveyed beaches. Opportunistic reports were provided by community members from Elim, Gambell, Golovin, Kivalina, Point Hope, Shaktoolik, Shishmaref, Nome and Utqiaġvik.

See the bottom of page 13 for information on reporting stranded marine mammals.



A satellite tag on a spotted seal. Photo by NOAA.

ICE SEAL STRANDINGS [24]



Graphics adapted from NOAA Fisheries

MARINE DEBRIS [25]

Starting in July 2020, unusual amounts of marine debris washed up in communities across the Bering Strait region. The beverage bottles, food containers, personal product containers, household aerosol cans and chemical cleaners were predominantly foreign in manufacture, with Russian and Korean labeling on many items. These were intermixed with items associated with fishing industry activities, such as deck boots, bucket liner bags and longline equipment.

Since the arriving debris appeared to be roughly similar age, type, and contained fresh fruits and vegetables, the best estimate indicates a point source release, such as accidental loss or intentional dumping from a vessel. NOAA used hindcast modeling to help identify the most likely locations where the debris could have entered the ocean. Based on wind and current patterns in late July, the model indicates debris most likely originated southwest of St. Lawrence Island.

Planning for the future

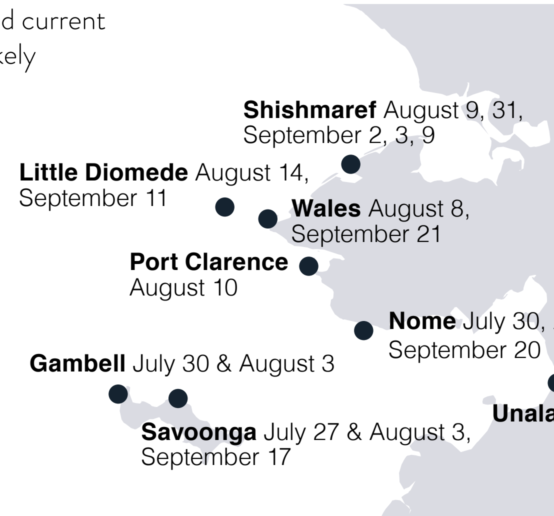
NOAA is working collaboratively with regional partners and responding organizations to find the best way to support immediate removal, disposal and monitoring during future incidents. This includes coordinating with government organizations and international groups to identify appropriate international government-to-government and industry channels for identifying the sources of debris and preventing future events, and capturing these in a report on the event and the response.

REPORT marine debris to NOAA, incident.debris@noaa.gov, or through regional channels like Alaska Sea Grant (907-434-1149) or Kawerak Inc. (907-443-4265).

Photo of marine debris clean-up from the point source incident in 2020. Photo by Kawerak.

DEBRIS SIGHTINGS

Coastal residents raised critical awareness and reported debris sightings. This map shows when debris associated with the July point source incident washed up in specific communities.



SEABIRDS [26]

The US Fish and Wildlife Service was unable to conduct most of their seabird research in the eastern and northern Bering Sea in 2020 due to COVID-19 travel restrictions. One month-long offshore survey provided information on at-sea distribution of seabirds. Otherwise, content from this page came exclusively from the 2020 Ecosystem Status Report and highlights efforts by coastal community members, Tribal governments and state/university scientists. What information is known about the status of seabirds in the region during 2020 is due, in large part, to their efforts.

The at-sea surveys found fairly average abundances of seabirds. However, short-tailed shearwater, a long-distance migrant which doesn't breed in Alaska, was particularly abundant and widespread. While in Alaska, the shearwaters feed primarily on euphausiids, suggesting these prey were widely available in late August – late September of 2020. There were slightly below average densities of murres, kittiwakes and auklets.

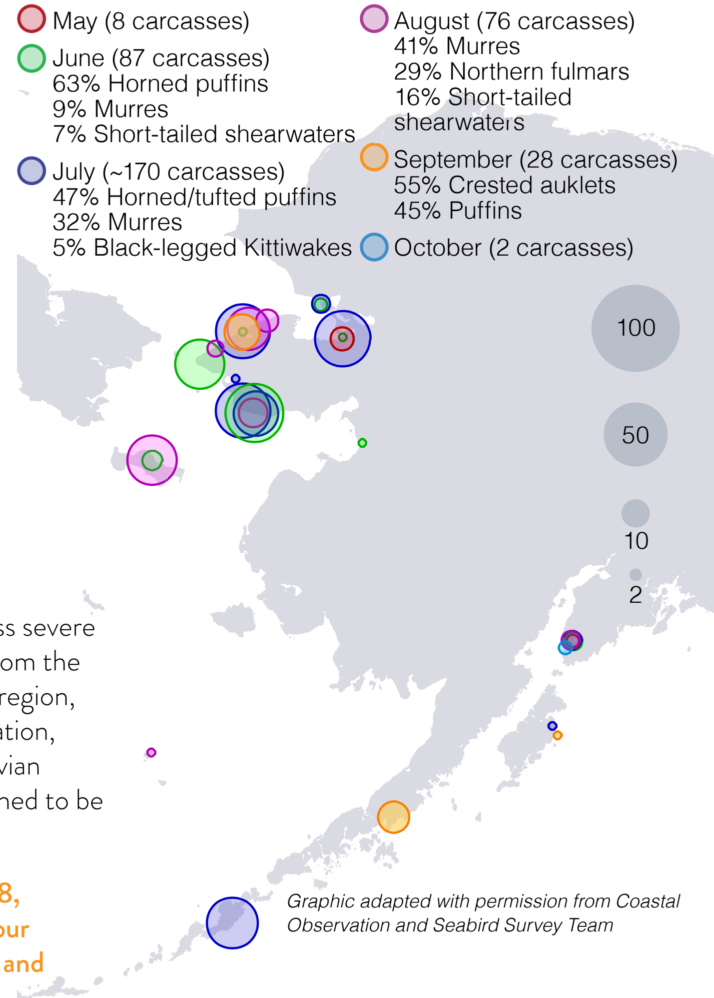
Die-off less severe

The seabird die-off that began in 2016 continued in 2020, but was much less severe than in the previous few years. Over 330 seabird carcasses were reported from the Bering Sea, with most found in the Bering Strait region. In the Bering Strait region, Tribal, State and Federal partners collected 25 seabird carcasses for examination, disease and harmful algal bloom testing. The carcasses tested negative for Avian Influenza. Eighteen received necropsies and the cause of death was determined to be emaciation. Concentration of saxitoxin in tissues was below detection levels.

REPORT sick or dead birds to US Fish and Wildlife Service (1-866-527-3358, ak_mbm@fws.gov) or through regional channels. Participate in monitoring your local beach for seabirds and marine debris as part of the Coastal Observation and Seabird Survey Team, which provides training. Visit www.coasst.org.

2020 SEABIRD CARCASS LOCATIONS [27]

Larger bubbles mean more carcasses. Colors show months.



Graphic adapted with permission from Coastal Observation and Seabird Survey Team

PRIBILOF ISLANDS [28]

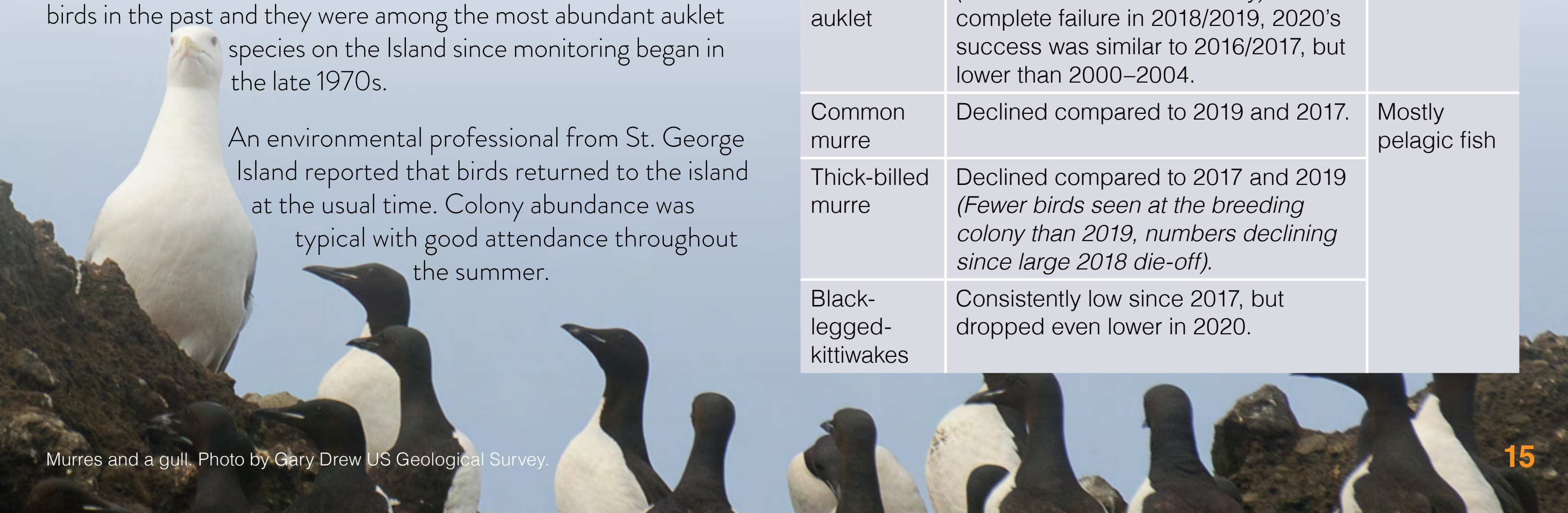
Pribilof Islands environmental professionals, known as the Island Sentinels, provided the only available seabird breeding data in 2020. Their observations suggest that it was an average, to slightly below average, year for most fish-eating seabird species (black-legged kittiwakes, common murres). Plankton-eating species (least auklets) have been declining in the Pribilof Islands in recent years, and 2020 continued that trend, at least on St. Paul Is. There was a complete lack of parakeet auklets on St. Paul Is. This is troubling because the population was estimated at over 30,000 birds in the past and they were among the most abundant auklet species on the Island since monitoring began in the late 1970s.

An environmental professional from St. George Island reported that birds returned to the island at the usual time. Colony abundance was typical with good attendance throughout the summer.

NORTHERN BERING SEA [29]

2020 St. Lawrence Island seabird data were collected by Punguk Shoogukwruk and Jason Annogiyuk, both residents of Savoonga.

Species	2020 reproductive success	Food
Least auklet	*(Chicks hatched 1 week early)* Low. Many chicks left nests before fully grown, seen wandering inland and in ponds. Suggests chicks began starving late in chick rearing period.	Mostly zooplankton
Crested auklet	*(Chicks hatched 1 week early)* After complete failure in 2018/2019, 2020's success was similar to 2016/2017, but lower than 2000–2004.	
Common murre	Declined compared to 2019 and 2017.	Mostly pelagic fish
Thick-billed murre	Declined compared to 2017 and 2019 *(Fewer birds seen at the breeding colony than 2019, numbers declining since large 2018 die-off).*	
Black-legged-kittiwakes	Consistently low since 2017, but dropped even lower in 2020.	



Murres and a gull. Photo by Gary Drew US Geological Survey.

WANT TO LEARN MORE?

Use this page and the orange circles found throughout the report to find an expert to whom you can send questions about each topic. Each expert is followed by the data or information sources for that item. The information throughout this report was gathered from many sources. Individuals and organizations shared some preliminary data from surveys or other activities, while other sections were summarized based on scientific papers or published reports.

Sections using the NOAA Ecosystem Status Reports are denoted by * and **. Below is contact information for the editor of each report. See orange numbers for an expert who contributed to that part of the Ecosystem Status Report and can answer specific data questions.

*Siddon, E.C. 2020. Ecosystem Status Report 2020: Eastern Bering Sea, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 99501. Contact: elizabeth.siddon@noaa.gov.

**Ortiz, I. and Zador, S. 2020. Ecosystem Status Report 2020: Aleutian Islands, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 99501. Contact: ivonne.ortiz@noaa.gov.

Climate update
Rick Thoman, Alaska Center for Climate Assessment and Policy, University of Alaska Fairbanks, rthoman@alaska.edu [Data source: 1 National Snow & Ice Data Center Sea Ice Index, V3; 2 NOAA/PSL/ESRL; 3 NOAA/NCEI & National Weather Service]

Storms
4 John Walsh, International Arctic Research Center, University of Alaska Fairbanks, jewalsh@alaska.edu [From: Redilla, K., et. al. (2019). Wind climatology for Alaska: historical and future. Atmospheric and Climate Sciences]

Rick Thoman, Alaska Center for Climate Assessment and Policy, University of Alaska Fairbanks, rthoman@alaska.edu [5 UAF/IARC/P. Bieniek; 6 Data source: ERA5 courtesy of ECMWF/Copernicus]

Storm impacts
Jacquelyn Overbeck, Alaska Department of Natural Resources, jacquelyn.overbeck@alaska.gov [From: 7 Overbeck, J.R., et al. 2020, Shoreline change at Alaska coastal communities: Alaska Division of Geological & Geophysical Surveys Report of Investigation 2020; 8 https://aoos.org/alaska-water-level-watch/]

Salmon
9 Kathrine Howard, Alaska Department of Fish & Game, kathrine.howard@alaska.gov

10 Sabrina Garcia, Alaska Department of Fish & Game,sabrina.garcia@alaska.gov

Walleye pollock
11 Lisa Eisner, NOAA Alaska Fisheries Science Center, lisa.eisner@noaa.gov [From: Eisner, L. B., et al. (2020). Environmental impacts on walleye pollock (Gadus chalcogrammus) distribution across the Bering Sea shelf. Deep Sea Research Part II: Topical Studies in Oceanography. https://bit.ly/3jfZWKP]

Crab
12 Erin Fedewa, NOAA Alaska Fisheries Science Center, erin.fedewa@noaa.gov [From: https://bit.ly/2Lgk96B]

13 Jenefer Bell, Alaska Department of Fish & Game, jenefer.bell@alaska.gov

Ocean acidification
14* Darren Pilcher, CICOES and NOAA Pacific Marine Environmental Laboratory, darren.pilcher@noaa.gov [From: Eastern Bering Sea Ecosystem Status Report, p 39]

15* Esther Kennedy, University of California Davis, egkennedy@ucdavis.edu [From: Eastern Bering Sea Ecosystem Status Report, p 41]

Harmful algal blooms
16** Thomas Farrugia, Alaska Harmful Algal Bloom Network, farrugia@aoos.org [From: Aleutian Islands Ecosystem Status Report, p 77]

17 Don Anderson, Woods Hole Oceanographic Institute, danderson@whoi.edu

Plankton
18* Lisa Eisner & Jens Nielsen, NOAA Alaska Fisheries Science Center, lisa.eisner@noaa.gov & jens.nielsen@noaa.gov [From: Eastern Bering Sea Ecosystem Status Report, p 74]

19* Phyllis Stabeno, NOAA Pacific Marine Environmental Laboratory, phyllis.stabeno@noaa.gov [From: Eastern Bering Sea Ecosystem Status Report, p 79]

20* David Kimmel, NOAA Alaska Fisheries Science Center, david.kimmel@noaa.gov [From: Eastern Bering Sea Ecosystem Status Report, p 82]

Gray whales
21 Mandy Keogh, NOAA Fisheries Alaska Region, mandy.keogh@noaa.gov [From: https://bit.ly/3thZ3pA]

22 Dave Weller, NOAA Southwest Fisheries Science Center, dave.weller@noaa.gov [From: https://bit.ly/3pNUYax]

23 Fredrik Christiansen, Aarhus University, f.christiansen@aias.au.dk [From: Christiansen, F., et al. (2021). Poor body condition associated with an unusual mortality event in gray whales. Marine Ecology Progress Series]

Ice seals
24 Mandy Keogh, NOAA Fisheries Alaska Region, mandy.keogh@noaa.gov [From: https://bit.ly/2YFmaMX]

Marine debris
25* Peter Murphy, NOAA Marine Debris Program, peter.murphy@noaa.gov; Gay Sheffield, Alaska Sea Grant, ggsheffield@alaska.edu [From: Eastern Bering Sea Ecosystem Status Report, p 36]

Seabirds
26* Robb Kaler & Kathy Kuletz, US Fish and Wildlife Service, robert_kaler@fws.gov and kathy_kuletz@fws.gov [From: Eastern Bering Sea Ecosystem Status Report, p 114]

27* Jackie Lindsey & Tim Jones, Coastal Observation & Seabird Survey Team, coasst@uw.edu [From: Eastern Bering Sea Ecosystem Status Report, p 114]

28* Lauren Divine, Aleut Community of St. Paul Island, lmdivine@aleut.com

29* Alexis Will, University of Alaska Fairbanks, awill4@alaska.edu [From: Eastern Bering Sea Ecosystem Status Report, p 114]