STATE OF KACHEMAK BAY

2021 HIGHLIGHTS FROM LONG-TERM MONITORING AND RESEARCH IN KACHEMAK BAY, ALASKA

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NCCOS NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

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Kachemak Bay's rich marine ecosystems support Cook Inlet communities and local economies through recreational, subsistence and commercial fishing, tourism, marine transportation and more. The Bay is also a remarkable "natural laboratory" to study changing marine ecosystems, with all the estuary and coastal habitats found in the Gulf of Alaska, including ocean, kelp, seagrass, rocky intertidal, mudflat, salt marsh and glacial river environments. Fish, shellfish, marine mammals and seabirds rely on these habitats and all these species are affected by changing ocean conditions.

The "State of Kachemak Bay" is produced each year to highlight marine ecosystem trends and recent findings from resource management, monitoring, and research activities in the area. The report provides an opportunity to share more widely recent findings from multiple local organizations. We'd love to get your comments, suggestions, and additional topics of interest for future editions. Please send questions and comments to Karyn.DeCino@noaa.gov.

Kachemak Bay fieldwork photos courtesy of Dr. Brenda Konar, College of Fisheries and Ocean Sciences, University of Alaska Fairbanks.

PARTNERS & CONTRIBUTORS

The "State of Kachemak Bay" is produced by the NOAA Kasitsna Bay Laboratory, with contributions from many partner organizations. Kasitsna Bay Lab is part of the National Centers for Coastal Ocean Science (NCCOS) within NOAA's National Ocean Service, which provides information to support coastal communities. Partners and funding organizations include: Kachemak Bay National Estuarine Research Reserve (NERR), NOAA National Weather Service, USDA Natural Resources Conservation Service, US Geological Survey, US National Park Service, University of Alaska Fairbanks, University of Alaska Anchorage, Center for Alaskan Coastal Studies, Alaska Ocean Observing System, National Science Foundation (Alaska Established Program to Stimulate Competitive Research or EPSCoR, Fire and Ice Project) and Exxon Valdez Oil Spill Trustee Council (Gulf Watch Alaska long-term ecosystem monitoring program).

North Gulf Oceanic Society
3430 Main Street Suite B1 Homer, Alaska 99603

NOAA — National Oceanic and Atmospheric Administration, U.S. Department of Commerce

Kachemak Bay National Estuarine Research Reserve

Alaska NSF EPSCoR Fire & Ice 2018-2023

AOOS Alaska Ocean Observing System

Gulf Watch Alaska

Center for Alaskan Coastal Studies — explore · connect · protect

NOAA National Weather Service

UAF University of Alaska Fairbanks

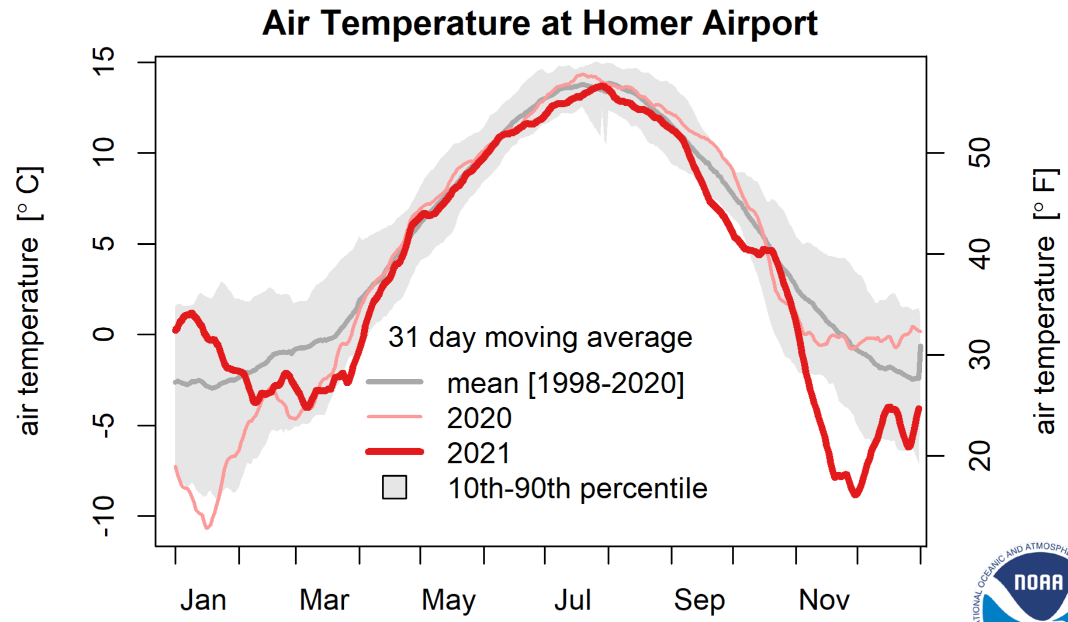
USDA United States Department of Agriculture — Natural Resources Conservation Service

University of Alaska Anchorage

USGS science for a changing world

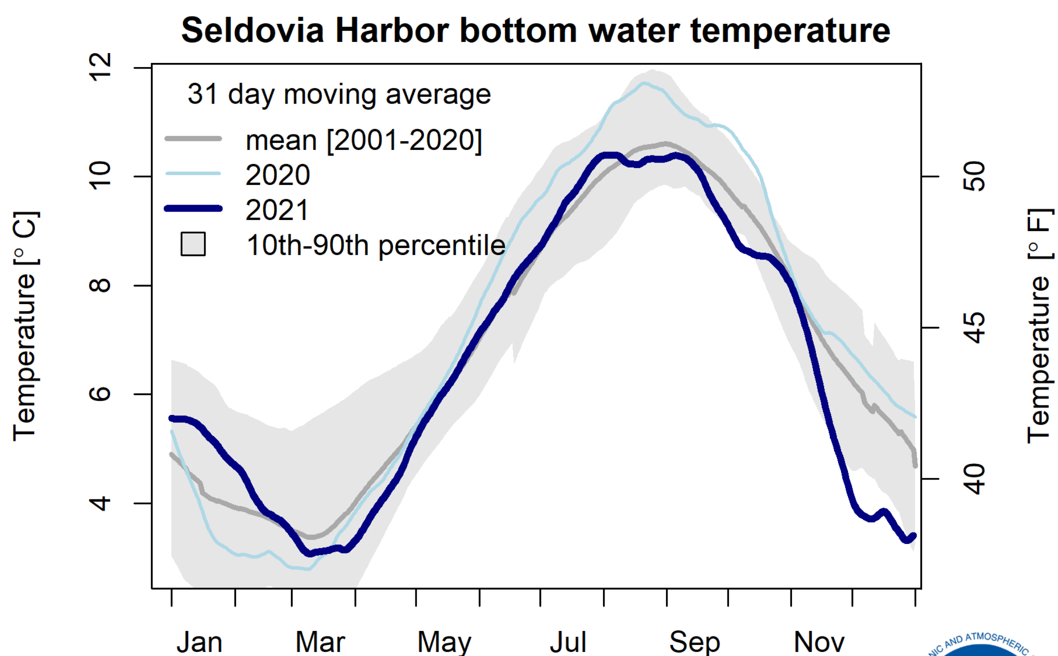
A LATE FALL COLD-SPELL...

2021 air temperatures started warm in January, cooled off in late winter and were close to normal in the summer. Fall months were cooler than normal, with an especially cold November and December. These late fall temperatures were even lower than January-February, the coldest months in most years. Learn more: martin.renner@noaa.gov (NOAA Kasitsna Bay Lab).



...CHILLS THE WATERS

The late fall cold-spell also affected Kachemak Bay waters, as shown in the unseasonably cold water temperatures observed in November and December at a long-term sampling site at Seldovia Harbor. Learn more: martin.renner@noaa.gov.

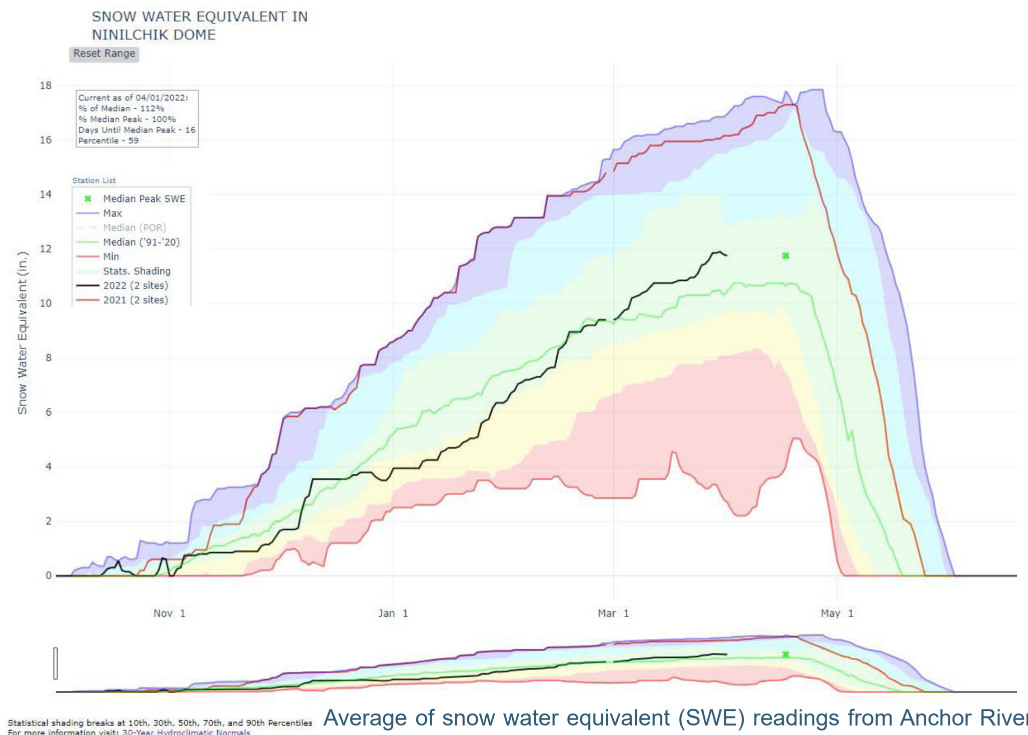


Data from Kachemak Bay NERR water quality station

ANOTHER SNOWY WINTER

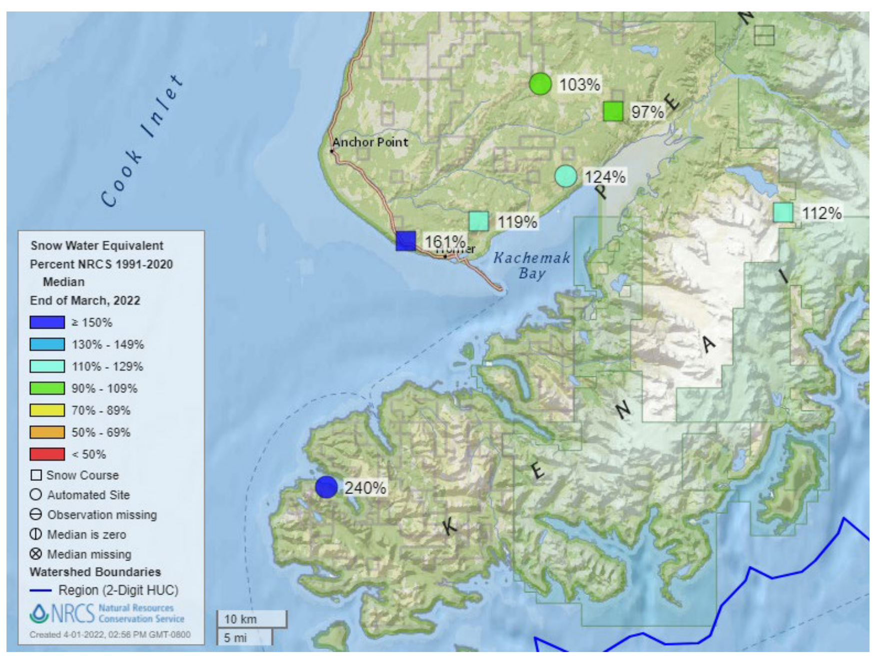
The snowpack around Kachemak Bay in winter 2021-2022 was above average for the second year in a row. The storm train started in December, stalled for most of January, then continued for much of the season. Snow favored the reporting stations closest to Cook Inlet. Homer Demonstration Forest and Port Graham boasted the highest deviation from normal, whereas the inland locations of Eagle Lake and Anchor River Divide were near normal.

United States Department of Agriculture
Natural Resources Conservation Service



Average of snow water equivalent (SWE) readings from Anchor River Divide and McNeil Canyon SNOTELS, April 1 SWE percent of 1991-2020 Median (normal)

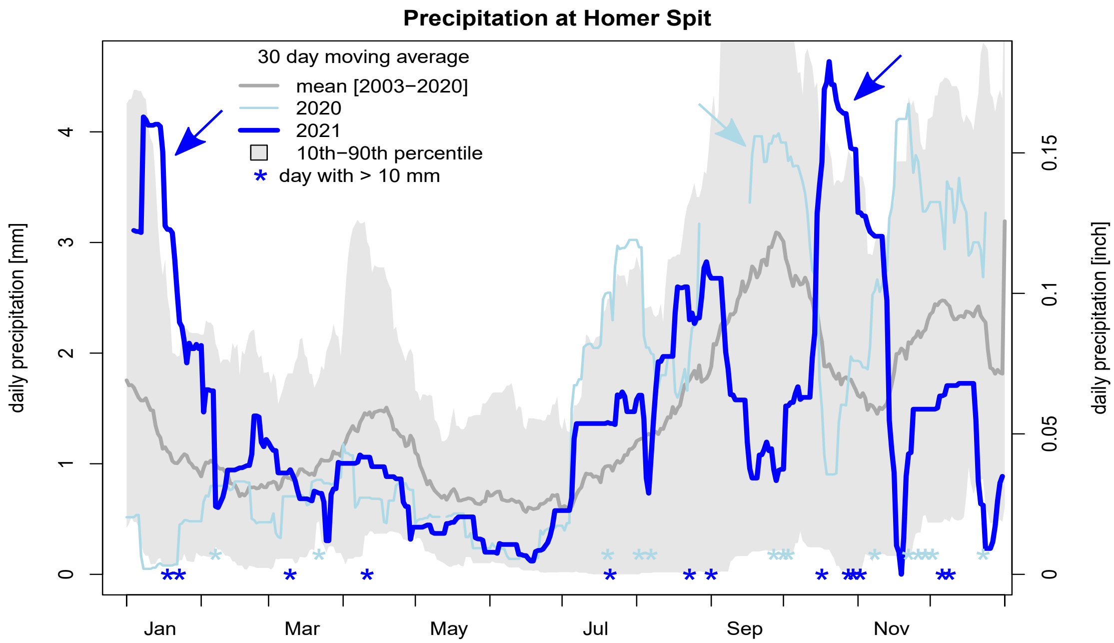
Early December 2021 snowfall at a house in Homer, on Diamond Ridge above the Homer Demonstration Forest monitoring site, which had 161% of normal snow water equivalent for the winter.

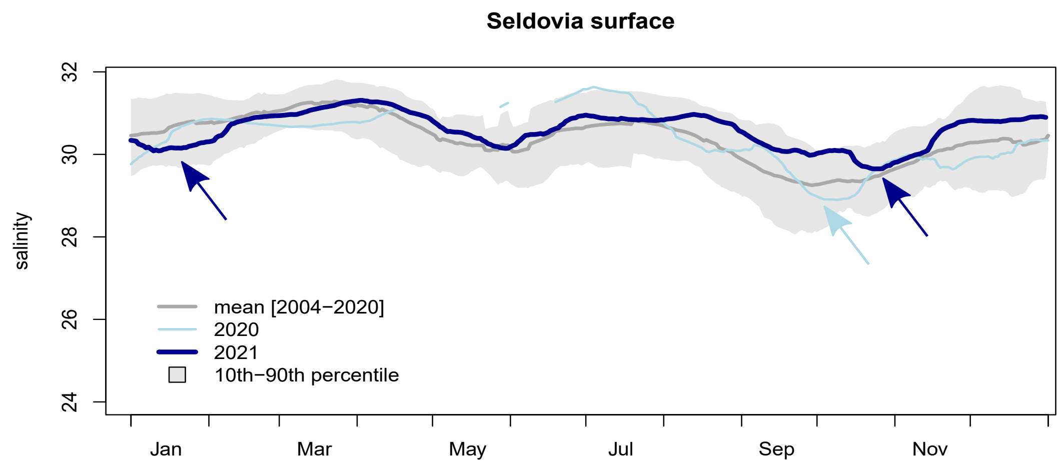


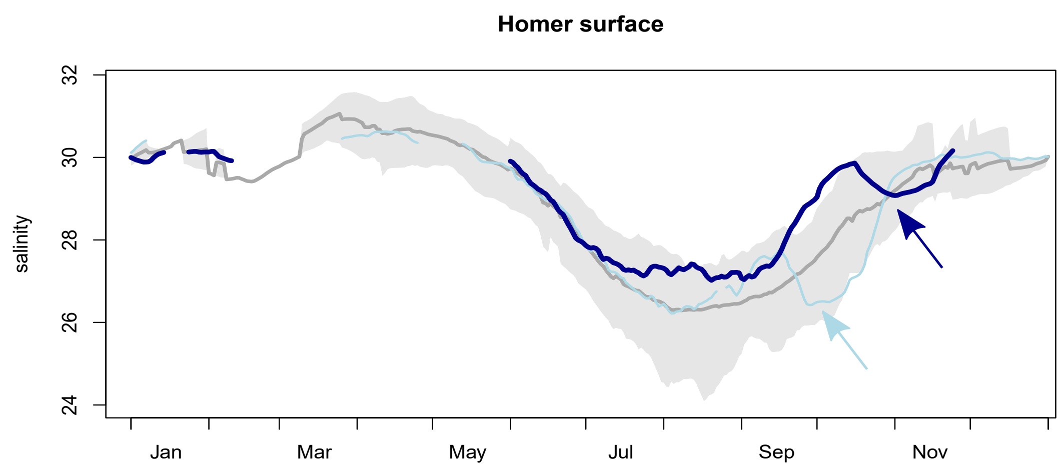
April 1, 2022 snow water equivalent (SWE), expressed as percent of 1991-2020 Median

HOW FAST CAN RAIN CHANGE BAY WATERS?

The annual precipitation observed at the Homer Spit weather station was slightly higher than average in 2021, with much higher than normal amounts in January and October (blue arrows on top graph). Interestingly, these two periods were wet enough to quickly make the bay less salty – as shown in the decreased salinity at both the Seldovia and Homer harbor water quality stations (bottom plots). A similar pattern was seen in September 2020 (light blue arrows). The much lower summer salinities observed at Homer also show how much more freshwater runoff comes from rain, snow, and glacier melt in the inner bay, compared to the outer bay conditions at Seldovia. Learn more: martin.renner@noaa.gov.



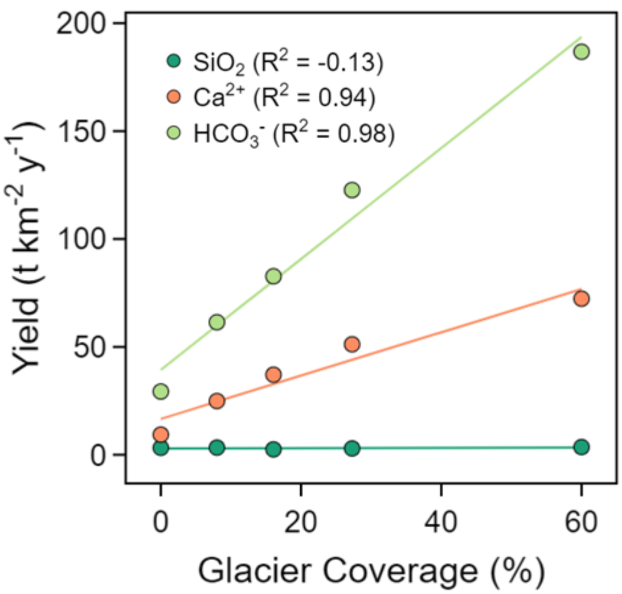


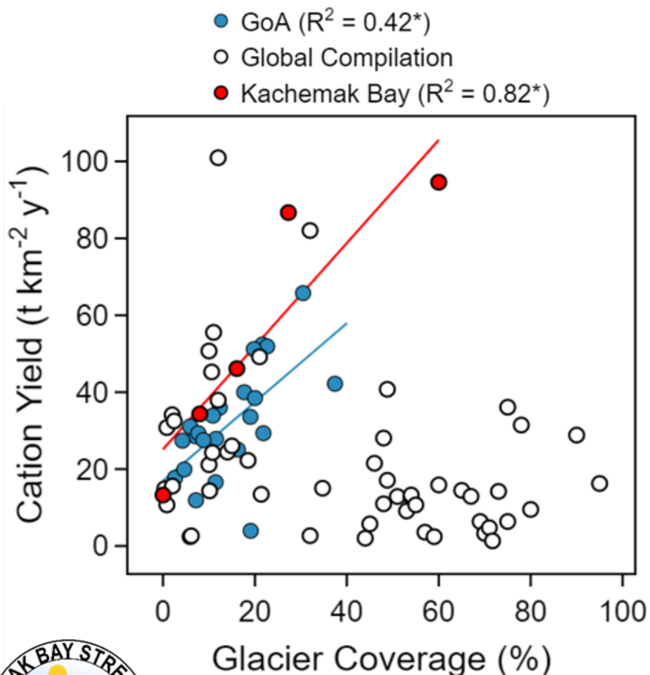


*The winter data gap for Homer salinity is due to the instrument being removed to prevent damage from freezing temperatures.

USING CHEMISTRY TO UNDERSTAND GLACIAL STREAMS

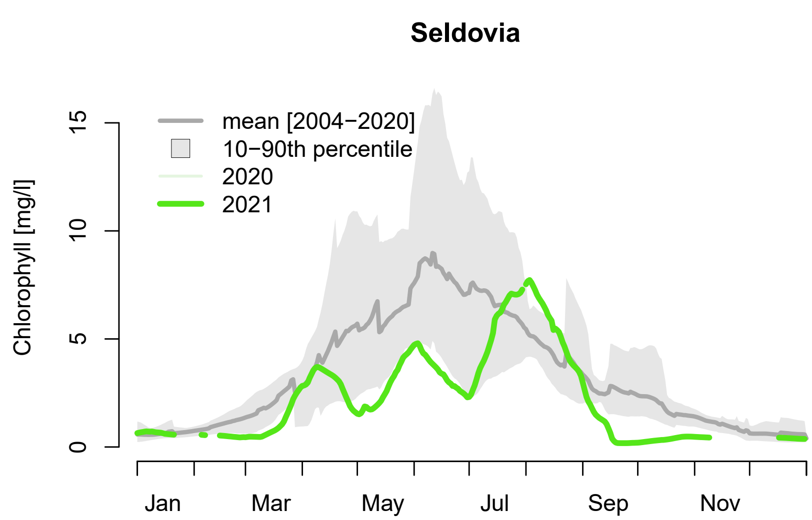
UAA researchers are measuring the chemistry of Kachemak Bay streams to understand how climate change and melting glaciers will affect the bay and Gulf of Alaska. The Grewingk, Halibut, Wosnesenski, Tutka and Jakolof stream watersheds have a range of glacier coverage (60 to 0%) and provide a natural testbed. Glacier coverage drives the amounts of positive (represented by calcium, Ca^{2+}), and negative (represented by bicarbonate, HCO_3^-) ions, but is not realated to amounts of silica (SiO_2). Positive ion (cation) yields in the bay streams are also similar to trends found in the Gulf of Alaska and globally. Learn more: Jordan Jenckes (jjenckes2@alaska.edu).



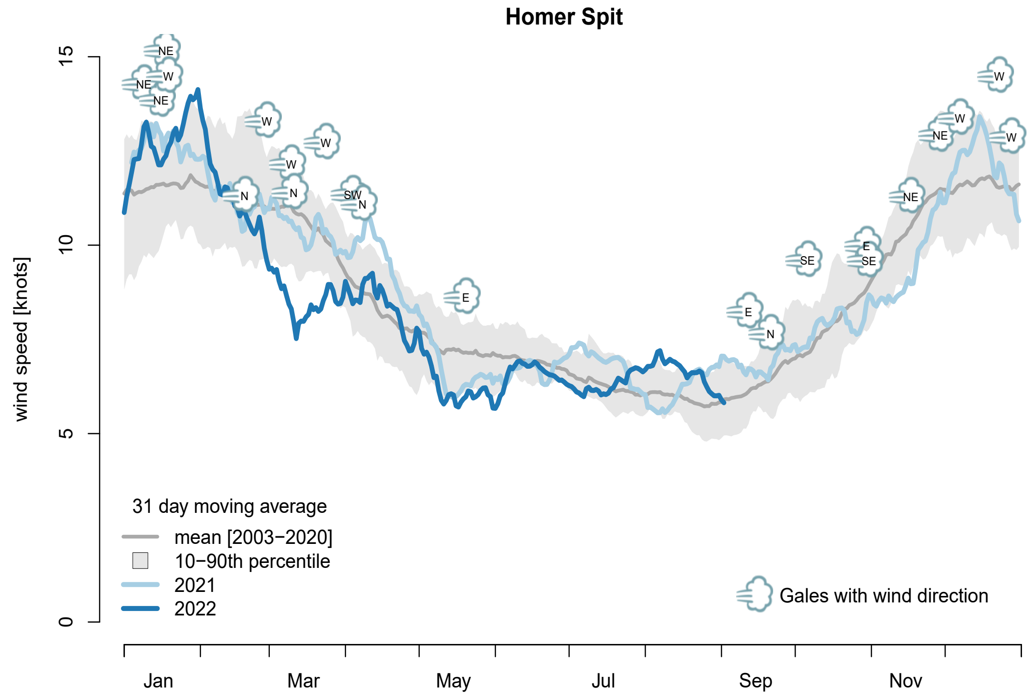


TRACKING THE BASE OF THE MARINE FOOD WEB

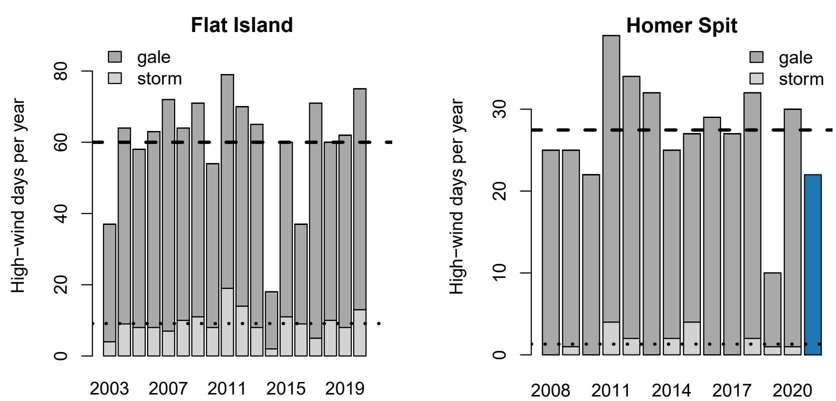
Phytoplankton are the base of the marine food web and chlorophyll concentrations are monitored at Seldovia and Homer harbors to track trends in plankton biomass. Normally, there is a large phytoplankton bloom and maximum chlorophyll in spring/early summer, due to increasing sunlight, followed by a decrease as phytoplankton are grazed by zooplankton. However, in 2021 chlorophyll concentrations were lower than normal at the Seldovia site, with more variability during the summer and highest amounts not occurring until late summer. Learn more: chguo@alaska.edu

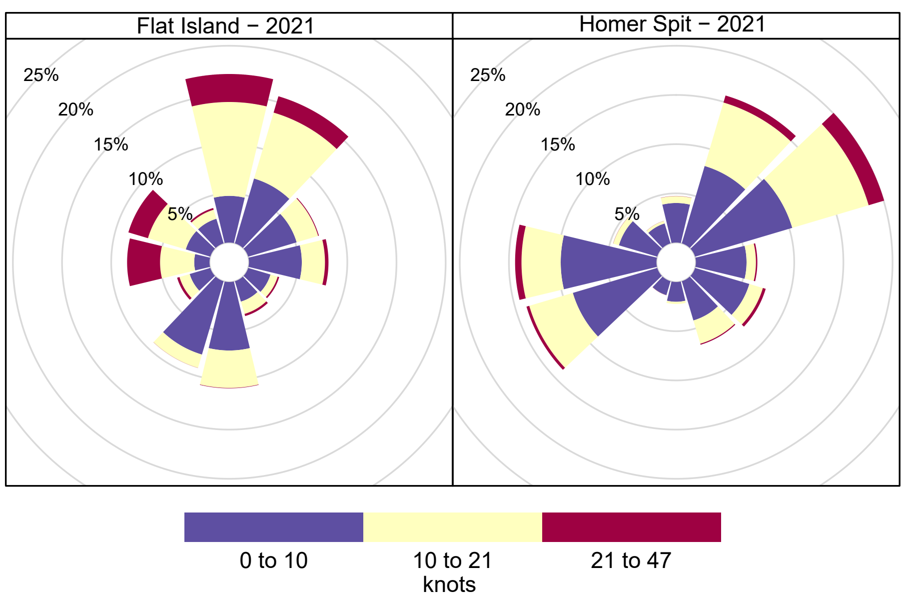


WINDS IN BAY AND INLET



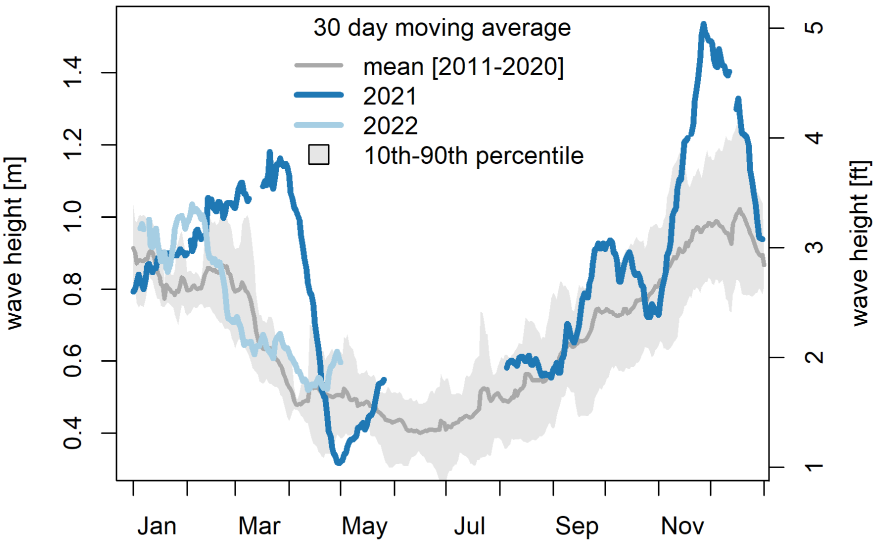
In 2021, it was windier than normal in January, April, December and much of the summer at the KBNERR weather station on the Homer Spit. However, overall there were fewer than normal gale force (> 34 knots) and no storm force (>48 knots) winds observed there (dashed line marks the average). By contrast, there were more gales than average observed at the Flat Island weather station near Nanwalek, and those Cook Inlet winds generally also affect wave conditions in the outer bay. Annual wind rose plots are another way to show differences in wind speed (colors) and direction (percentage circles) between the Homer Spit and Flat Island in 2021. Flat Island had higher winds, with the strongest winds blowing from the north and west, versus from the northeast and southwest at the Spit. Learn more: martin.renner@noaa.gov.





BIG WINTER WAVES

The windier conditions in lower Cook Inlet were likely responsible for higher than average wave conditions observed at the wave buoy in outer Kachemak Bay for much of 2021, especially in April and at the end of the year. Learn more: AOOS.org and martin.renner@noaa.gov.

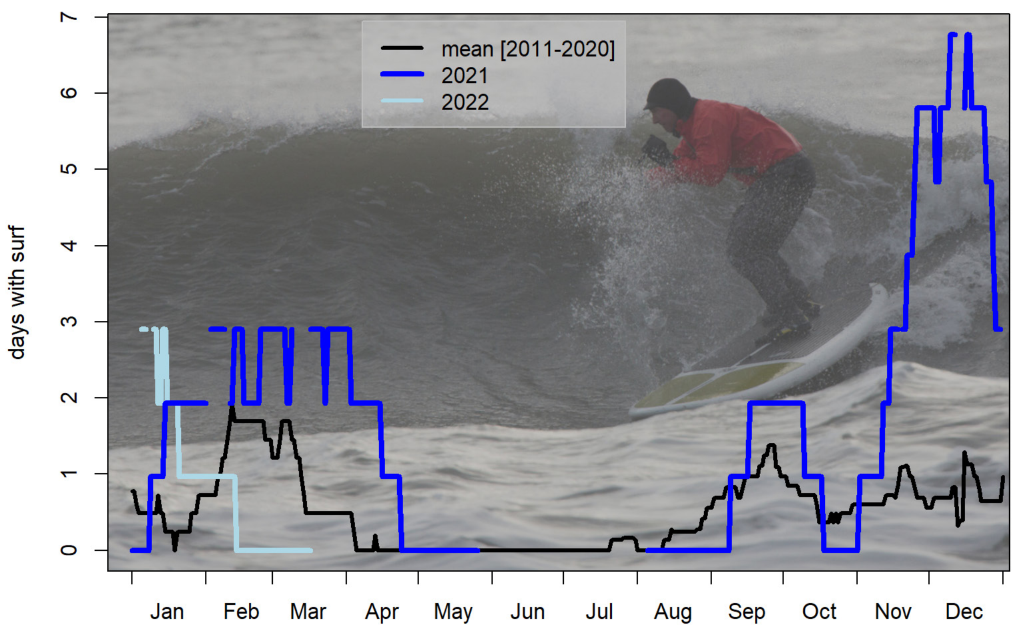


*Wave buoy was out for maintenance during the summer of 2021.

Replacing the Alaska Ocean Observing System (AOOS) wave buoy in outer Kachemak Bay

SURF'S UP!

The prolonged periods of higher waves were challenging for running small boats, but did provide great conditions for surfers, especially in November-December 2021. Even the usually quiet spring months of March and April offered surfing opportunities. Learn more: martin.renner@noaa.gov



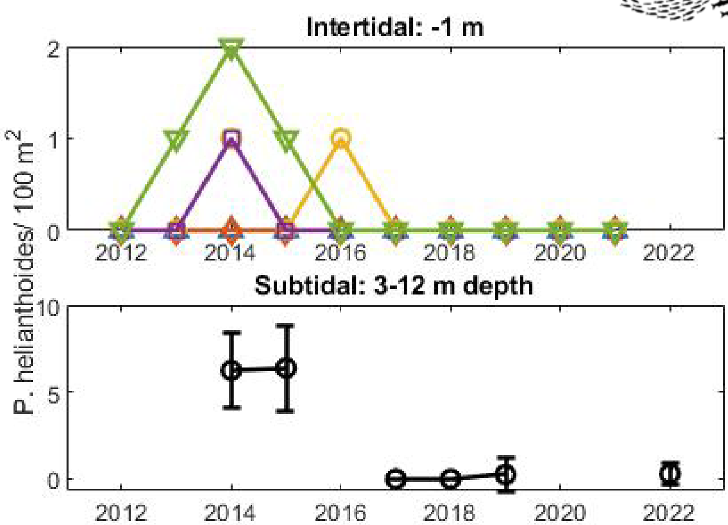
Kachemak Bay Surf Index for winter 2021-2022. Background photo of local Bay surfer.

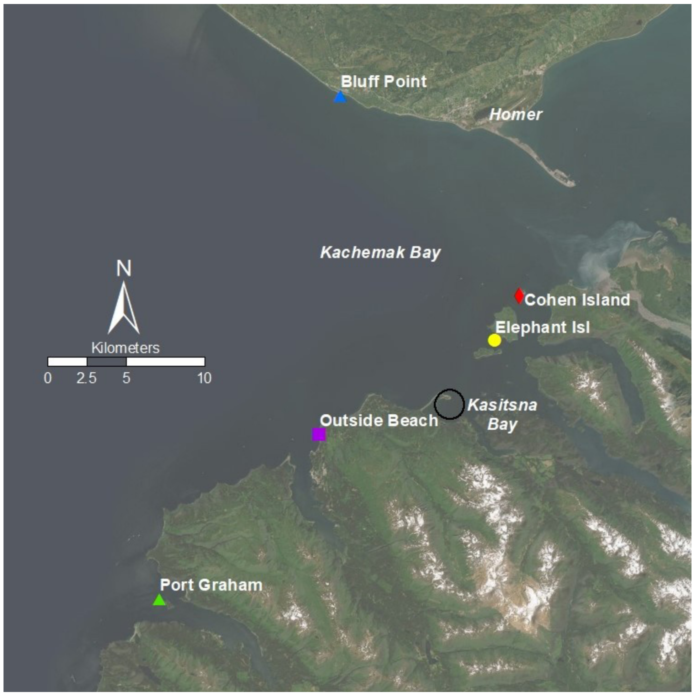
WILL THE SUN(FLOWER SEA STARS) COME OUT TOMORROW?

Assessing Recovery of the Sunflower Sea Star after Wasting Disease

Sunflower sea stars, *Pycnopodia helianthoides*, are important predators in coastal systems. Starting in 2016 in Kachemak Bay, they were impacted by an outbreak of sea star wasting disease. Sunflower stars are counted in the low rocky intertidal as part of the Gulf Watch Alaska monitoring program (gulfwatchalaska.org). Sunflower stars were not common in the low intertidal prior to the appearance of sea star wasting, but were present in low densities at some sites. No sunflower sea stars have been observed at the Gulf Watch Alaska intertidal sites in Kachemak Bay since 2016; however, they have since been reported at non-Gulf Watch sites in very low densities.

In Kachemak Bay, sunflower stars tend to be more abundant in deeper water than in the rocky intertidal, so it is important to also consider data from the subtidal zone. University of Alaska Fairbanks students have counted sunflower stars in the subtidal zone during the Scientific Diving field course taught by Dr. Brenda Konar (UAF) at the Kasitsna Bay Laboratory since 2014. Sunflower stars disappeared at this site after the sea star wasting outbreak but were present at low densities in 2019 and 2022. Continued monitoring is needed to assess sunflower star recovery and the effects of future disturbances.





Timeseries of sunflower star densities in the low intertidal (upper panel) and subtidal zone (lower panel). Shape and color corresponds to the site locations on the map (right).

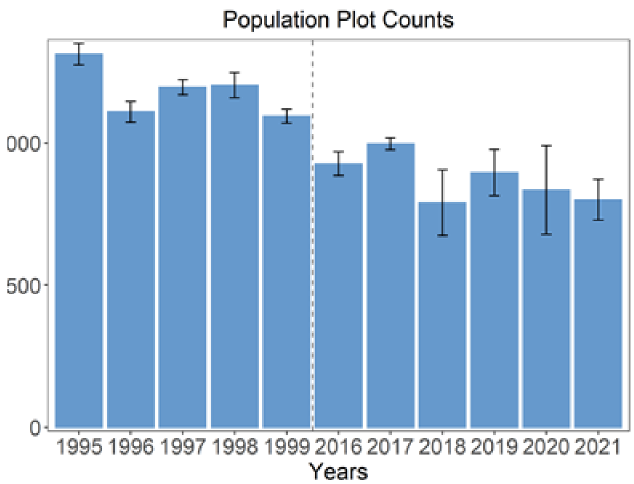
A healthy sunflower star hunting for clams (left) and a star with symptoms of sea star wasting (right).

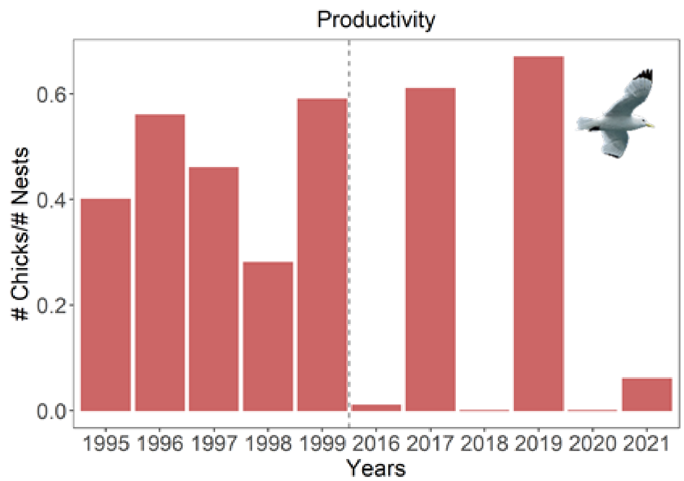
ANOTHER BAD YEAR FOR SEABIRDS ON GULL ISLAND

The USGS monitored Black-legged Kittiwake and Common Murre populations on Gull Island from 1995-1999, and from 2016-2021, following the 2014-2016 northeast Pacific marine heatwave. USGS research, which is supported by the USGS and BOEM, includes population monitoring, and quantifying breeding success and predator disturbances. This information is preliminary or provisional and is subject to revision. Learn more: https://www.usgs.gov/centers/alaska-science-center/science/cook-inlet-seabird-and-forage-fish-study

Black-legged Kittiwakes

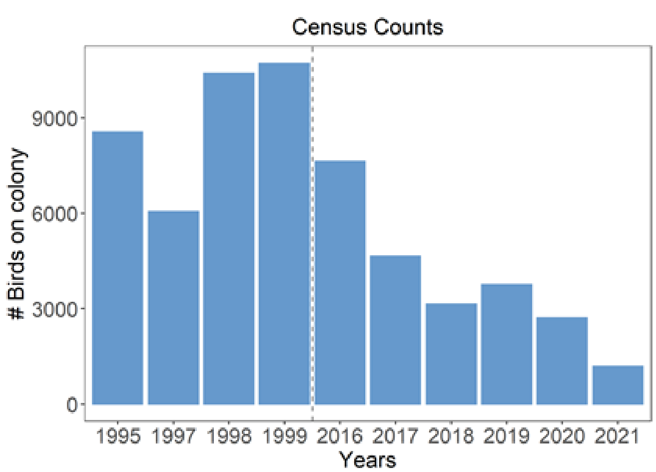
Average kittiwake attendance (mean number of birds across population plots; left graph) at Gull Island declined by 27% after the heatwave (to the right of the dotted line) compared to baseline levels pre-heatwave. The estimate of productivity (right graph) for kittiwakes in 2021 was very low, with only 6 in 100 nesting pairs raising chicks to fledge. This continues the trend of unusually variable success in years following the heatwave.

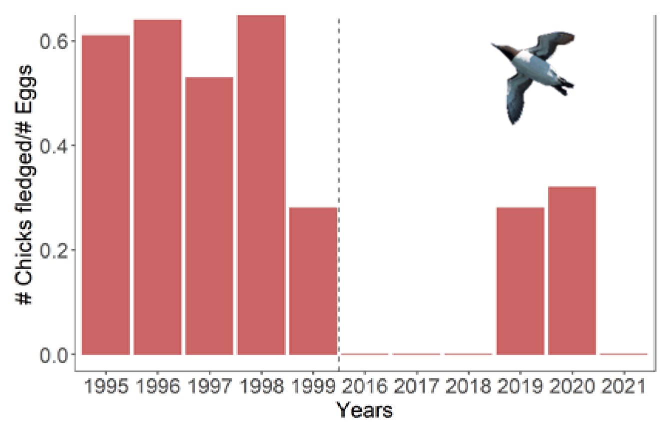




Common Murres

Murre attendance (annual number of birds colony-wide; left graph) at Gull Island in 2021 was the lowest on record. Average attendance decreased by 57% following the heatwave (to the right of the dotted line) from baseline levels. We attribute declines in attendance to losses of birds from the 2015-2016 murre die-off, as well as reduced recruitment following multiple years of reproductive failure. Murres experienced another year of reproductive failure in 2021, following two years of low productivity (right graph).





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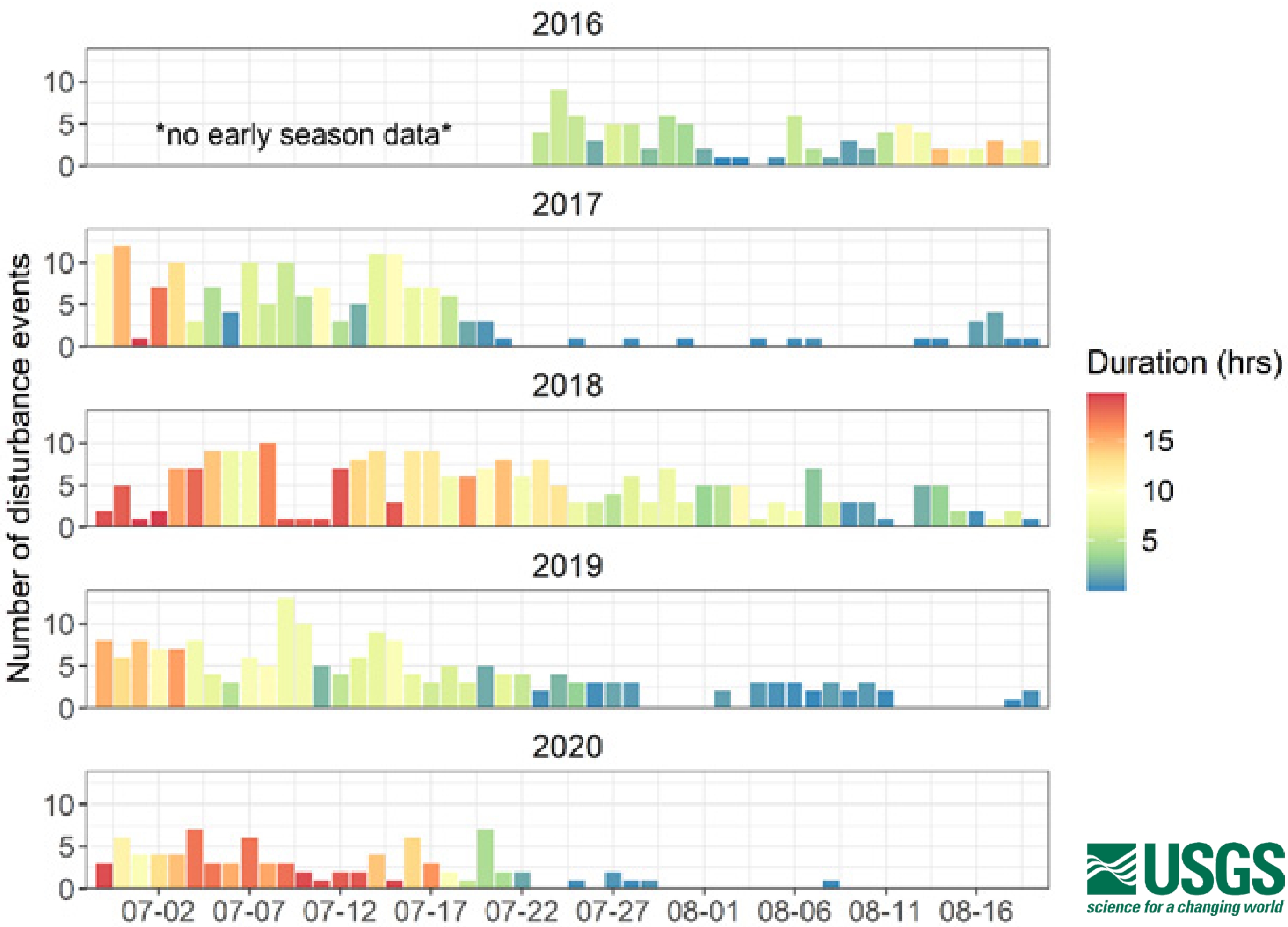
EAGLES DISTURB SEABIRDS ON GULL ISLAND

Predator Disturbances to Common Murres

Large scale disturbances on Gull Island, often caused by Bald Eagles, flush seabirds from the colony and leave eggs and chicks vulnerable to predation. High rates of predation reduce hatching success and can compound the effects of food stress on overall breeding success. Predator disturbances on murres was measured by the number (height of bars) and duration (color of bars) of disturbance events (per day) that were recorded by cameras on top of the colony. These data help identify changes in disturbance within and among years. For example, disturbances were more frequent later in the season in 2016 and 2018 and were of longer duration in the early season in 2018 and 2020, compared to other years.



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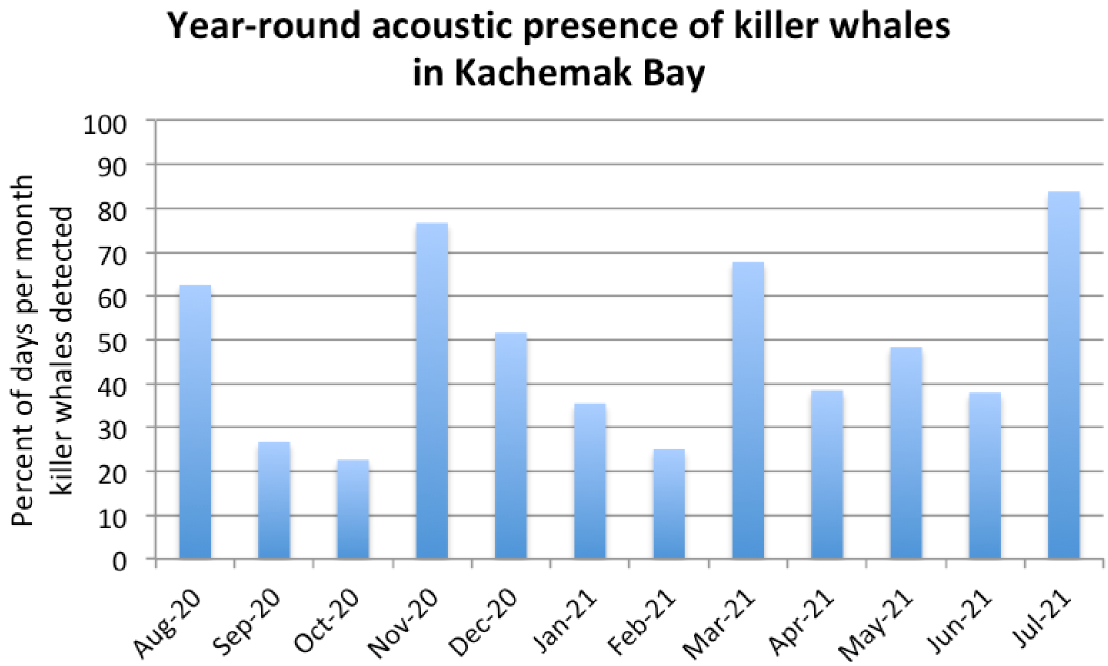
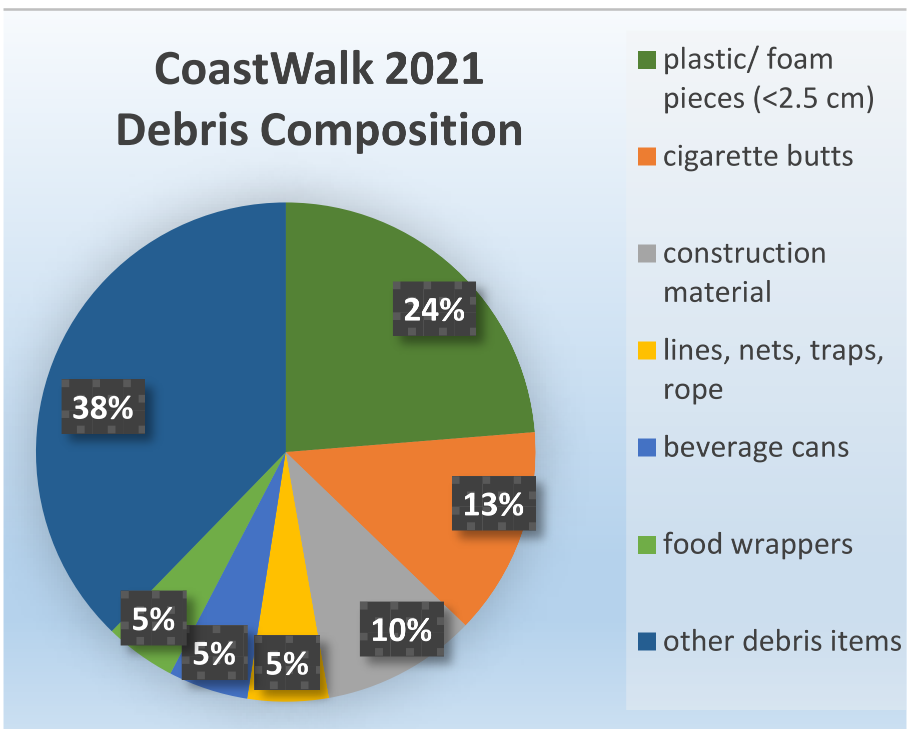
LISTENING FOR KILLER WHALES IN KACHEMAK BAY

Three killer whale ecotypes spend time in Kachemak Bay: residents, which eat fish; transients, which eat marine mammals; and offshores, which eat primarily sharks. Passive acoustics allow us to monitor these top predators year round. A hydrophone deployed in Kachemak Bay in August 2020 is contributing to long-term passive acoustic monitoring of killer whales across important areas in the northern Gulf of Alaska. This figure shows the percent of days per month that killer whales were detected in Kachemak Bay between August 2020 and July 2021. Next steps involve acoustically identifying the ecotypes, pods, and number of animals present. Learn more: Hannah Myers, hmyers8@alaska.edu.



KACHEMAK BAY COASTWALK 2021

During CoastWalk cleanups in 2021, 510 volunteers cleaned 19 miles of beach, removing and recording 1290 pounds of debris, consisting of 14,400 items. Many of the top items found were similar to previous years with foam pieces and cigarette butts being common. The data collection system was updated, adding a category for Personal Protective Equipment (PPE) and another for e-cigarettes. Other categories were combined. For more detailed information: https://www.akcoastalstudies.org/outreach/international-coastal-cleanup.html



HARMFUL ALGAL BLOOMS (HABS)

Phytoplankton are microscopic plant-like organisms are an essential part of a healthy marine ecosystem. Over 50 phytoplankton species are commonly found in Kachemak Bay, and three species produce toxins that can be harmful to people. When these species of concern are abundant, the toxins they produce can accumulate in shellfish and cause harmful algal bloom events, including paralytic shellfish poisoning, or PSP.

Community monitors and KBNERR staff collected over 170 phytoplankton samples from 21 locations across Southcentral Alaska in 2021 to monitor for the presence of harmful phytoplankton. NOAA Kasitsna Bay Lab researchers also collected samples during monthly shipboard oceanography surveys across the Bay. In 2021, phytoplankton species of concern were present at least ten months of the year in Kachemak Bay, but testing of wild shellfish never found PSP toxin levels above regulatory limits for human consumption. A large scale *Mesodinium rubrum* bloom occurred in the spring of 2021 and caused the water to change color at the head of the bay, but it was not harmful.

KBNERR's updated Marine Phytoplankton of Southcentral Alaska guide includes more species with new illustrations. The guide can be found online: https://bit.ly/3deIR2d

Aerial view of *Mesodinium rubrum* bloom courtesy of Ted Otis, ADF&G.

EUROPEAN GREEN CRAB (EGC) REACHES ALASKA

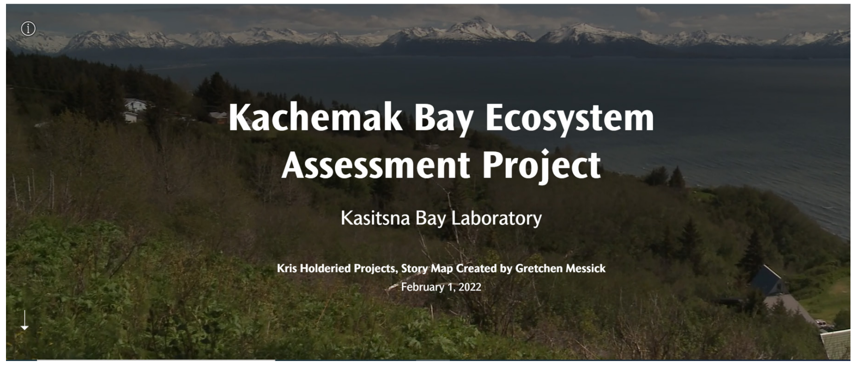
EGCs are an aggressive invasive species that are spreading up the West Coast. In 2021 they were found as far north as the island of Haida Gwaii in British Columbia, just south of the Alaska border, and then trapped in southern Southeast Alaska in early 2022.

Early detection is the most effective way to remove invasive species and minimize harmful impacts. In the summer of 2021, KBNERR staff and community monitors completed 6 trapping events to monitor for European Green Crab and none were found. If you want to join the volunteer network for the early detection and response planning for EGC email Jasmine at jrmaurer@alaska.edu. Please report any sightings of potential invasive species to 1-877-INVASIV.

NOAA KASITSNA BAY LAB: MAKING COASTAL DATA & SCIENCE AVAILABLE

NOAA Kasitsna Bay Laboratory leads and hosts research on coastal habitat and ecosystem changes due to climate change, harmful algal blooms, ocean acidification, oil spills and human activities. Multidisciplinary data from many different organizations, as well as local and traditional knowledge, are needed to understand and help Kachemak Bay communities respond to these changes. One of our goals is to make coastal data and science results more readily available for decision-making by coastal managers and the public. Explore some examples below and check out our Kachemak Bay Ecological Assessment project website for more information.

Learn more about the Kachemak Bay Ecological Assessment, the products and tools developed to date, and those still to come. From online viewers to a summary of changes over the past 20 years, there is much to explore. Dive in here.



The GeoHUB is a curated collection of Kachemak Bay research and monitoring projects. Resources include program and organization websites, online spatial data viewers and GIS data, and reports and publications. Explore the variety of Kachemak Bay resources here.

Online Spatial Data Viewers	Viewer link
Kachemak Bay 3D BIOMapper (NOAA/NCCOS)	https://noaa.maps.arcgis.com/apps/webappviewer3d/in
Kachemak Bay 2D BIOMapper (NOAA/NCCOS)	https://nccos-coastalsciencemaps-web-staging.azureweb
Kachemak Bay Bivalve Viewer (UAA/ACCS)	https://www.arcgis.com/home/item.html?id=c6a5a9929
Lower Cook Inlet, AK, CDIP Wave & Current Buoy 204 (AOOS)	https://portal.aoos.org/#metadata/52551/station/data
Cook Inlet Operational Forecast System (NOAA)	https://tidesandcurrents.noaa.gov/ofs/ciofs/ciofs.html
Natural Resources Spatial Viewer (Seldovia Village Tribe)	http://svtnode.com/spatialviewer/
Cook Inlet Response Tool (AOOS & CIRCAC)	https://portal.aoos.org/cirt
Spatial bibliography of deep-water exploration and research in Alaska (NOAA/NCCOS)	https://maps.coastalscience.noaa.gov/alaskaspatialbiblio
Alaska Fish Resource Monitor (ADFG)	https://www.adfg.alaska.gov/sf/SARR/AWC/index.cfm?A
Mariculture Map (AOOS)	https://mariculture.portal.aoos.org/
LEO Network (Alaska Native Tribal Health Consortium)	https://anthc.org/what-we-do/community-environment-
ShoreZone	http://www.shorezone.org/
OceanReports Tool (NOAA)	https://oceanservice.noaa.gov/ocean/ocean-reports/
National Data Buoy Center (NOAA)	https://www.ndbc.noaa.gov/
Environmental Response Management Application, Arctic/Alaska (NOAA)	https://erma.noaa.gov/arctic/erma.html#/layers=3+1005
Bathymetric Data Viewer (NOAA)	https://maps.ngdc.noaa.gov/viewers/bathymetry/
GIS Data Sites	**Data access**
ADFG Alaska Habitat Management Guides: 1985	http://www.adfg.alaska.gov/index.cfm?adfg=maps.habit
ADFG GIS Data Downloads	http://www.adfg.alaska.gov/index.cfm?adfg=maps.data
Alaska Environmental Sensitivity Index (ESI)	https://response.restoration.noaa.gov/esi_download#Al

Sea otters are a common sight in Kachemak Bay, with a population that increased dramatically before becoming more stable in the past decade. Learn more about their life history and role in the local ecosystem through this Story Map.

NOAA Kasitsna Bay Lab is part of the National Centers for Coastal Ocean Science (NCCOS) under NOAA's National Ocean Service. NCCOS delivers ecosystem science solutions for stewardship of the nation's ocean and coastal resources, to sustain thriving coastal communities and economies. NCCOS partners with the University of Alaska Fairbanks on lab operations, research and education.

For more information about NOAA and NCCOS: Kris.Holderied@noaa.gov and https://coastalscience.noaa.gov/about/facilities/alaska

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