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NOAA/NCCOS Kasitsna Bay Laboratory
coastalscience.noaa.gov

STATE OF KACHEMAK BAY

2020 HIGHLIGHTS FROM LONG-TERM MONITORING IN KACHEMAK BAY, ALASKA

Kachemak Bay had a frigid start to 2020, followed by warmer than average summer waters and then the best winter snowpack since 2012. Pacific cod populations started to increase and more mussels were seen in the intertidal, but seabird breeding success remained low. Though some field work was cancelled due to the COVID19 pandemic, researchers found ways to sample safely and start new projects, including listening for whales.

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Kachemak Bay's rich marine ecosystems support Cook Inlet Alaska community 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 their populations are also affected by changing ocean conditions.

The "State of Kachemak Bay" is an annual report that summarizes marine ecosystem trends and recent findings from resource management, monitoring, and research activities in the Bay by many different organizations. NOAA Kasitsna Bay Laboratory scientists compile the report, with contributions from local partners. We'd love to get your comments on the report, as well as suggestions for improving future editions.
Please send questions and comments to Karyn.DeCino@noaa.gov.

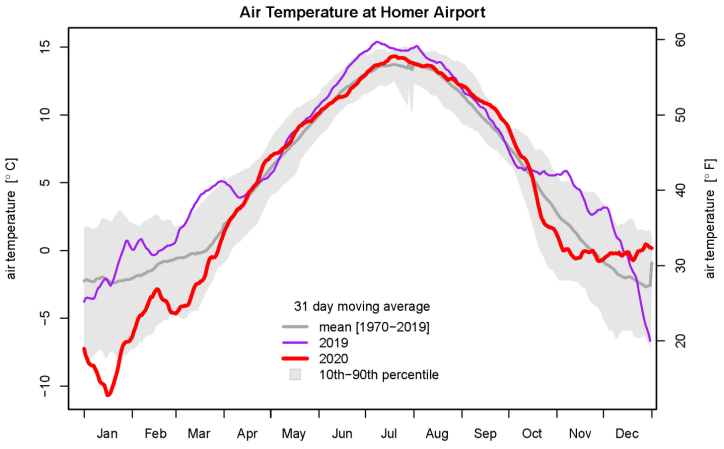
This report was initiated as one product of a larger project, the NOAA Kachemak Bay Ecological Assessment, which aims to provide better information to people living and working in the Kachemak Bay region. More information about the project, as well as access to data, online data viewers and other information tools can be found at the project website: https://coastalscience.noaa.gov/project/ecological-assessment-for-kachemak-bay-alaska-science-tools-to-inform-management/

PARTNERS & CONTRIBUTORS

Report development is led by the NOAA Kasitsna Bay Laboratory, which is part of the National Centers for Coastal Ocean Science (NCCOS) within NOAA's National Ocean Service. Many partner and funding organizations made this report possible, including: Kachemak Bay National Estuarine Research Reserve (NERR), Alaska Department of Fish and Game, NOAA National Weather Service, USDA Natural Resources Conservation Service, US Geological Survey, US National Park Service, University of Alaska Fairbanks, University of Alaska Anchorage, Cook Inlet Aquaculture Association, Center for Alaskan Coastal Studies, Tern Again Consulting, Alaska Ocean Observing System, National Science Foundation (Alaska Established Program to Stimulate Competitive Research or EPSCoR), and Exxon Valdez Oil Spill Trustee Council (Gulf Watch Alaska long-term ecosystem monitoring program).

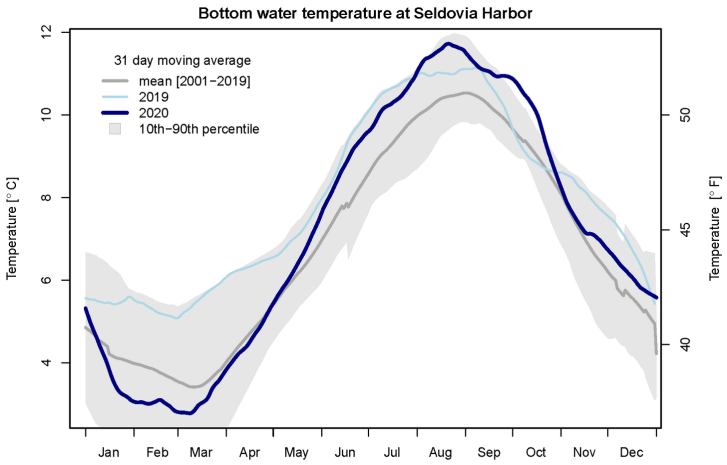
A COLD START...

2020 started out with a prolonged deep freeze in January and colder than normal air temperatures through March, which was a big change from the relatively hot conditions seen throughout 2019. For most of the rest of the year temperatures were near normal, with warmer conditions in September and December. Learn more: martin.renner@noaa.gov (NOAA Kasitsna Bay Lab)



... WARM SUMMER WATERS

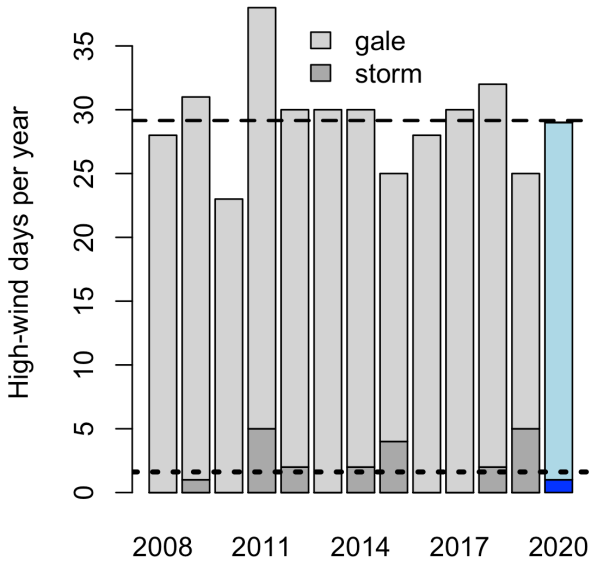
Water temperatures in Kachemak Bay were also colder than normal from January to March 2020, then shifted to warmer than normal in May and remained well above average all summer and fall. September and October temperatures were more than 3 degrees F above the seasonal mean. Interestingly, 2020 summer waters were relatively warm, while air temperatures were near normal, indicating that the warm bay waters were due to larger Pacific Ocean patterns. Learn more: sjbaird@alaska.edu (Kachemak Bay NERR) and martin.renner@noaa.gov



Data from Kachemak Bay NERR water quality station

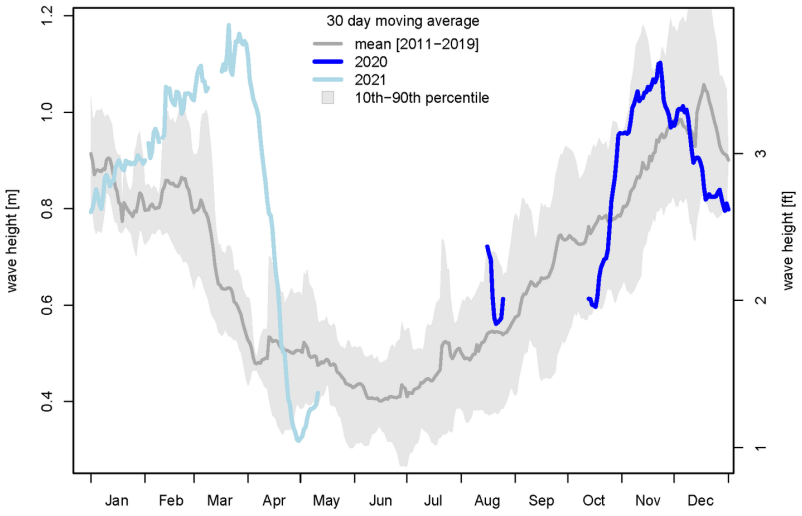
.. AND AVERAGE NUMBER OF STORMS

The number of high-wind days, with gale-force (34 knots) or higher wind speeds, in 2020 matched almost exactly the long-term average (dashed line near top of figure). Amongst those, there was one day with storm-force winds (48 knots or more) on 23 December 2020. Storm winds are rare at the Homer airport station, occurring 0-5 times per year, with a mean of 1.7 per year (dotted line near bottom of figure).
Learn more: martin.renner@noaa.gov



BIG WINTER WAVES

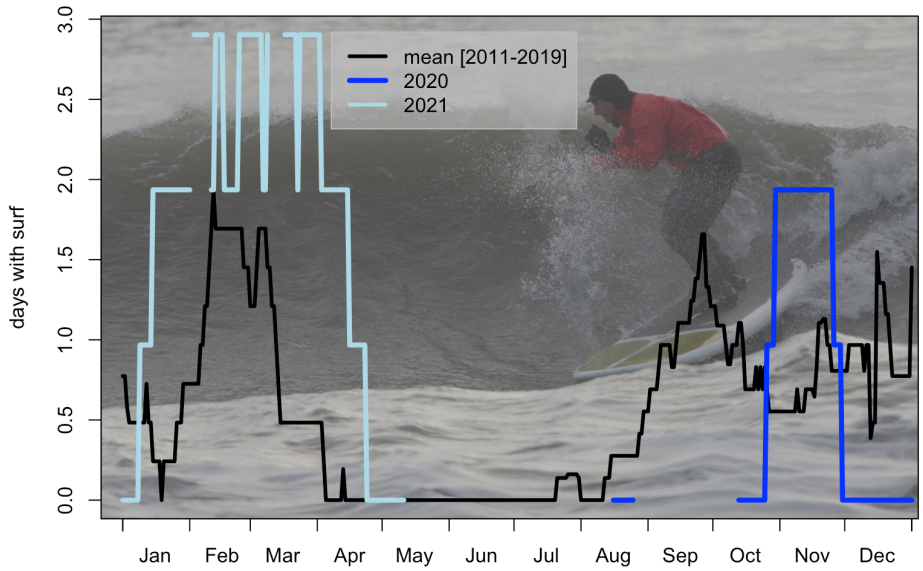
Wave heights are routinely measured at an Alaska Ocean Observing System buoy in outer Kachemak Bay – the only wave observations in all of Cook Inlet! Waves are generally highest in late fall and winter months, due to higher winds over both the bay and ocean during that time of the year. The wave buoy is challenging to maintain in the Bay's strong tidal currents, and was unfortunately out of service for much of 2020. However, it was redeployed in time to capture very high waves throughout November 2020, as well as a prolonged period of storms and much higher than average sea states between February and mid-April 2021. On 28 February 2021, the buoy recorded wave heights of 17.7 feet, which is close to the maximum observed for this location since the buoy was first deployed in 2012. Learn more: AOOS.org and martin.renner@noaa.gov



Note: Wave data was not available for much of 2020, because the wave buoy failed and its replacement was delayed.

SURF'S UP!

High surf conditions contribute to coastal erosion, but are also enjoyed by hardy local surfers. These surfers know that south-westerly swells, with longer wave periods and slight offshore winds, make for good wave riding conditions on the west side of Homer Spit. Here, we turn that local knowledge into a seasonal surf condition index – which shows there were lots of good surfing opportunities in the winter of 2020/2021. Seasonal averages from 2011-2019 show that February, early March and September are generally the best months to catch a wave in Kachemak Bay. Learn more: martin.renner@noaa.gov

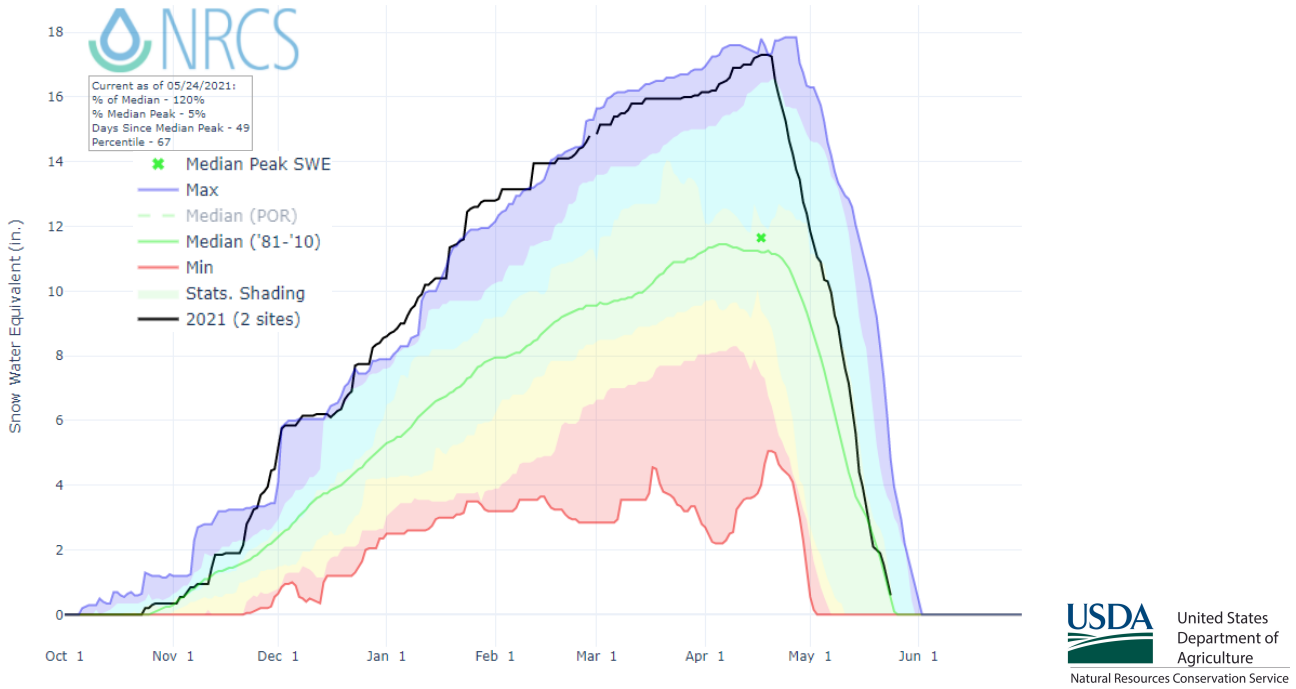


Kachemak Bay Surf Index for winter 2020-2021. Background photo of local Bay surfer.

BEST SNOWPACK SINCE 2012

The snowpack was above average this winter around Kachemak Bay, due to steady accumulation throughout the season (see black line in first figure for winter 2020-2021 accumulation). This was not true for the eastern Kenai Peninsula, where snow accumulations started out strong in early winter, but then tapered off after mid-January. This is the most robust snowpack Kachemak Bay has experienced since 2012, which is also the last year the area experienced an above normal snowpack, compared to the 1981-2010 climate normal period.

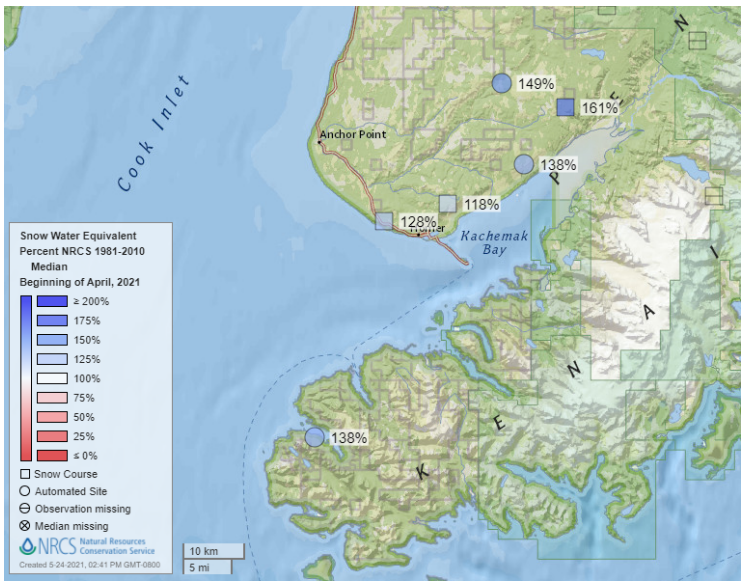
Average of snow water equivalent (SWE) readings from Anchor River Divide and McNeil Canyon SNOTEL sites.



Graph source: https://bit.ly/3dtZuqP

HAPPY SKIERS

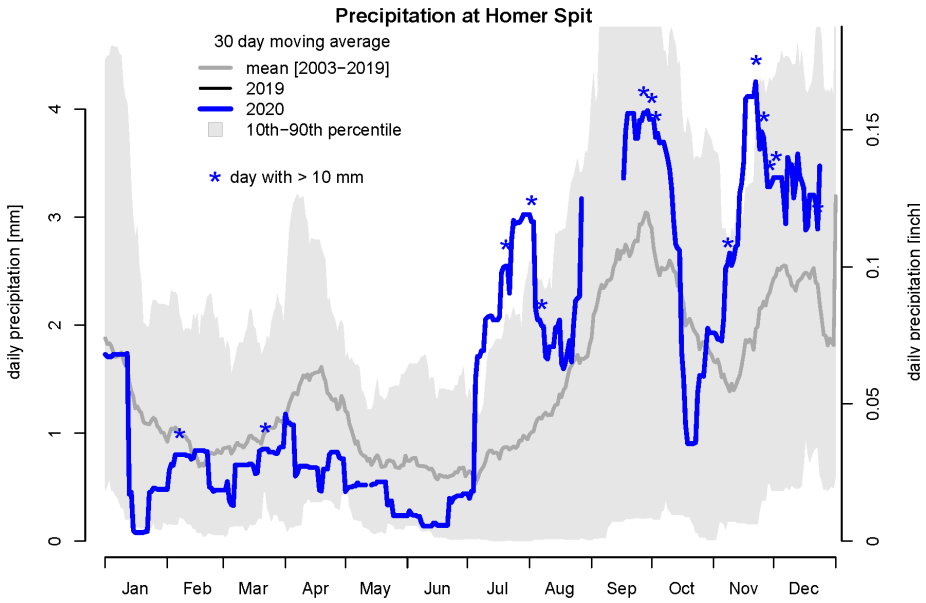
Snow measurement sites in the Kachemak Bay area recorded above average snowpack in winter 2020/2021, as indicated by the blue colors at all measurement sites. Snowpack affects wildlife, ground water, water flow in rivers, green-up dates for spring vegetation, and wildfire hazard.



Map source: https://bit.ly/3jbhSbm

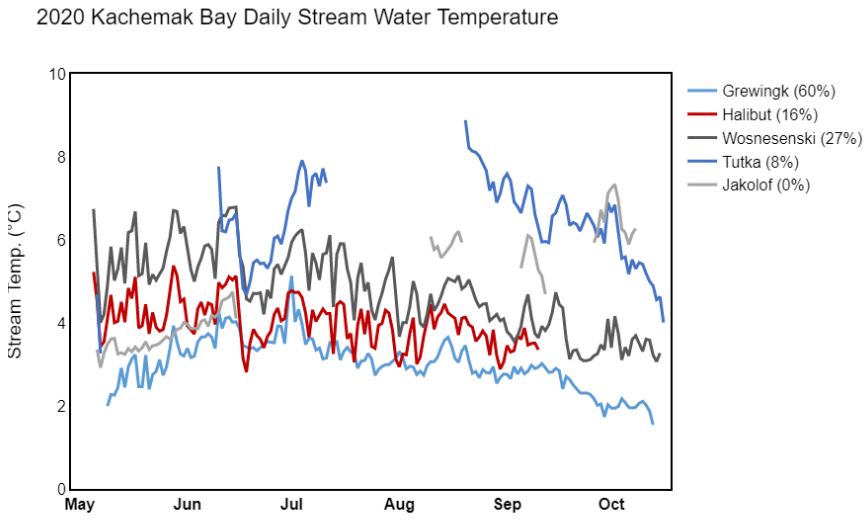
EXTRA RAINY JULY AND NOVEMBER

Precipitation patterns in 2020 were generally within normal seasonal ranges, with slightly lower than average precipitation during the first half of the year and higher than average precipitation for the last half of the year. July and November 2020 stood out as particularly wet, with a number of large rain events. The total number of high precipitation events for 2020 (14) was above the annual average (12.3), but not an unusually large number. Learn more: martin.renner@noaa.gov, sjbaird@alaska.edu



GLACIAL STREAM TEMPERATURES

Streams on the south side of Kachemak Bay are being monitored to understand the effects of climate on variably glacierized watersheds. Continuous measurements of stream water temperature (figure below) and stream levels are key to assessing sources and fluxes of freshwater to the Bay. Water temperatures at the Grewingk stream site (60% glacial cover), were consistently colder than other streams. However, factors such as catchment size and geomorphology also matter, as shown by consistently warmer temperatures at the Wosnesenski River site as compared to the Halibut stream site. Interestingly, Jakolof (0% glacial cover) has been observed to completely dry up during certain times of the year as indicated by gaps in the temperature data. This project will help us understand the influences of snowpack, glacial melt, groundwater and watershed characteristics on seasonal patterns of freshwater inputs to the Bay. Learn more: https://bit.ly/3l9MhI9

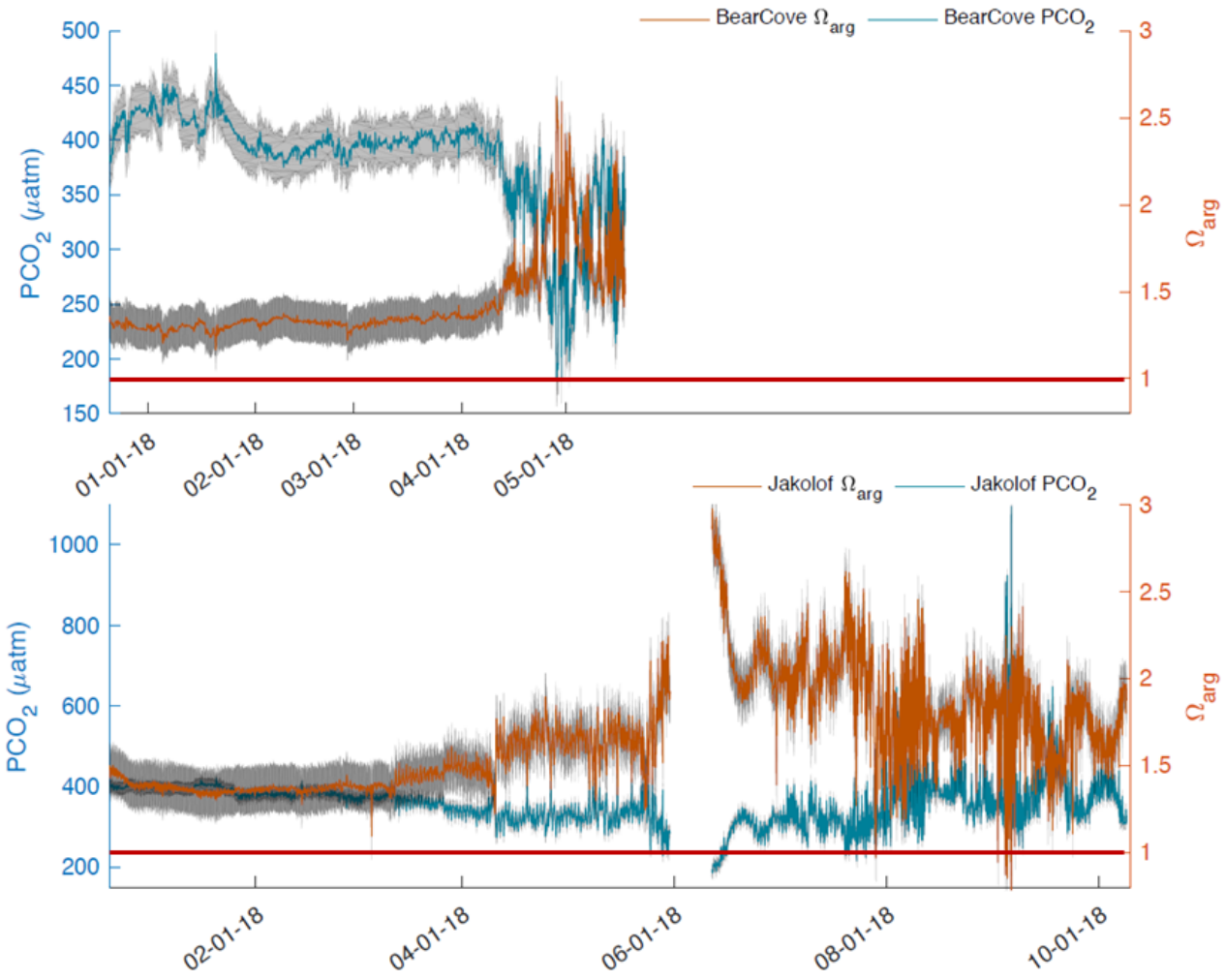


Daily water temperatures in five Kachemak Bay streams. The relative percent of glacial cover in each stream watershed is shown in the legend.

OA MONITORING SHOWS THAT BIOLOGY CHANGES WATER CHEMISTRY!

Ocean acidification (OA) causes changes in coastal water chemistry that can make it more difficult for animals such as clams and oysters to make shells from calcium carbonate in seawater and also affects the growth and behavior of other animals, including some fish species. Since October 2017, OA sensors have been deployed in four sites to frequently measure pH and other carbonate chemistry parameters, including the amount of carbon dioxide in the water and aragonite saturation state. Aragonite saturation indicates how easy it is for animals to build shells, and when it is less than 1, shells can dissolve. Recently published results demonstrated that most of the observed high variability in these conditions was driven by biological processes of photosynthesis and respiration, showing that the intense productivity of the Bay changes its water chemistry! Also, while saturation states are low in wintertime, they mostly stay above 1, which favors calcification and shell-building and is good news.

Learn more: Miller, C. A., & Kelley, A. L. (2021). Seasonality and biological forcing modify the diel frequency of nearshore pH extremes in a subarctic Alaskan estuary. Limnology and Oceanography, 66(4), 1475-1491.

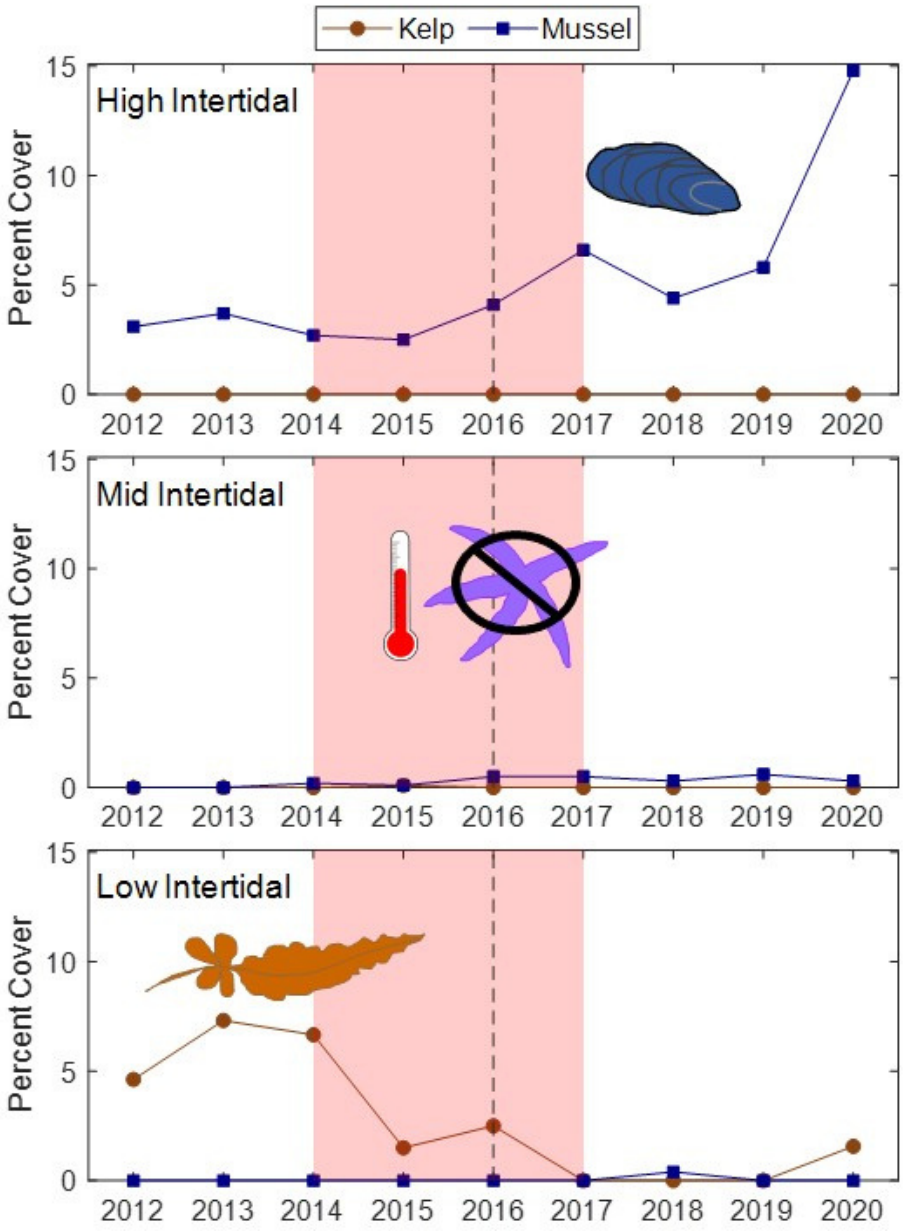


Estimated carbon dioxide (PCO2, blue line) and aragonite saturation state (Ωarg, orange line) from sites in a) Jakolof Bay (December 2017-October 2018) and b) Bear Cove (December 2017-May 2018). Grey envelope is the total uncertainty of the estimated values.

A TALE OF TWO NEARSHORE DISTURBANCES

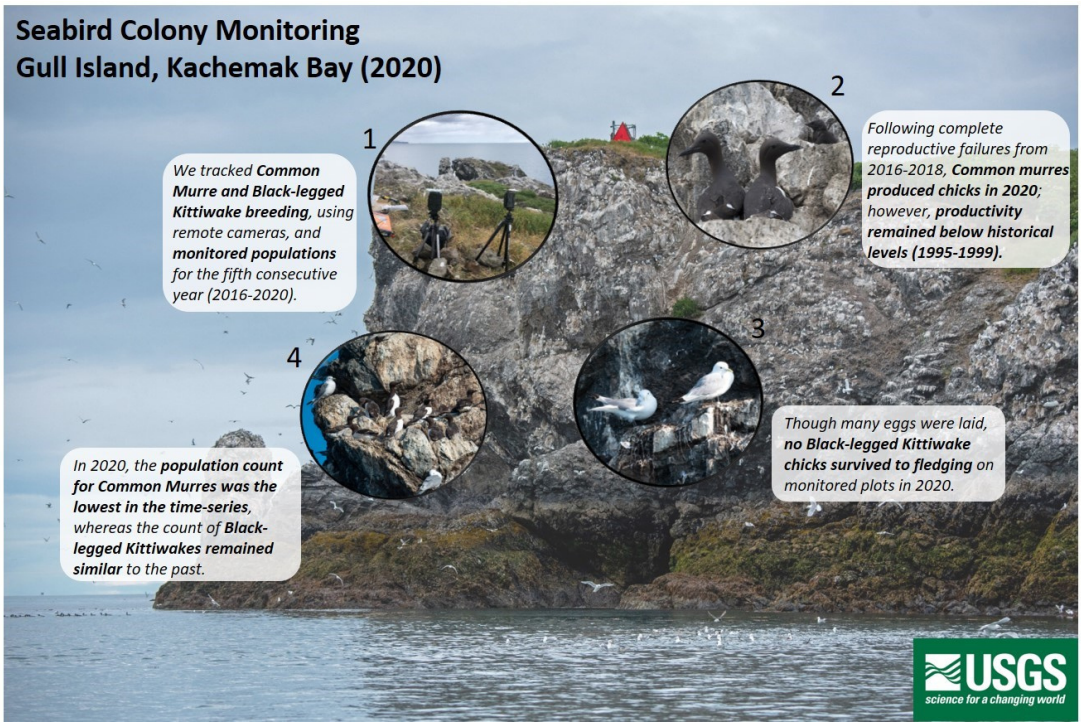
Long-term, nearshore monitoring in Kachemak Bay under the Gulf Watch Alaska program allows us to observe changes in important intertidal species. Over the past nine years, two large disturbances have affected Kachemak Bay, the 2014-2016 Pacific marine heat wave (red shaded area) and an outbreak of sea star wasting syndrome in 2016 (vertical dashed line) that reduced sea star numbers. Kelp cover in the low intertidal declined during the heatwave and has remained much lower compared to before the heatwave. Mussels seem to have benefited from the marine heatwave and sea star die-off since mussels are more resistant to high temperatures than other species and their sea star predators were reduced in numbers. Percent cover of mussels increased after these disturbances in the mid and high intertidal. These patterns in kelp and mussel cover were observed across the northern Gulf of Alaska study area of the Gulf Watch Alaska program.

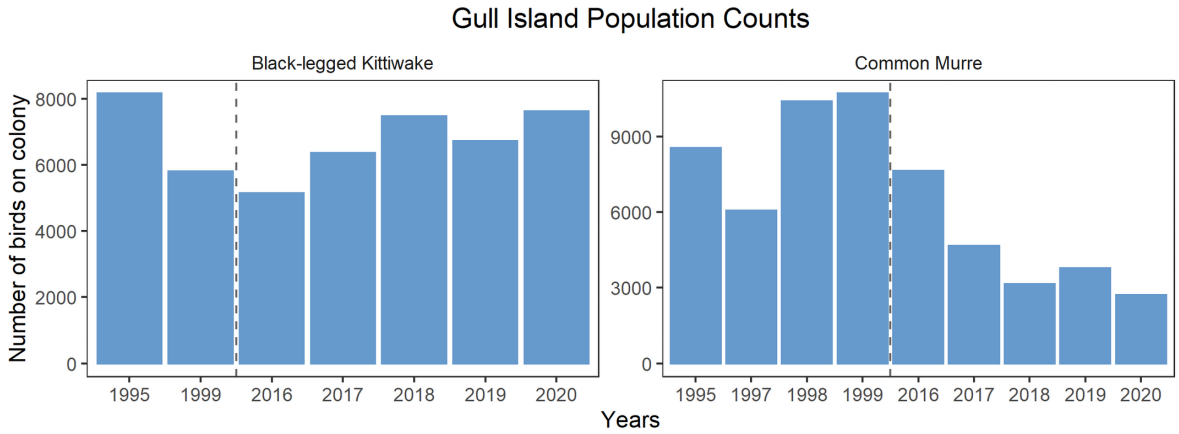
Learn more: https://bit.ly/3xYGIzz



SEABIRDS AND FORAGE FISH ECOLOGY PROGRAM

USGS Alaska Science Center monitored breeding productivity and population indices of Common Murres and Black-legged Kittiwakes at Gull Island in Kachemak Bay following the North Pacific marine heatwave of 2014-2016. During this time, we observed multiple years of unprecedented breeding failures in both murres (2016-2018) and kittiwakes (2016 and 2018). In 2020, Common Murres produced chicks for the second consecutive year, but at lower rates than the historical average, whereas Black-legged Kittiwakes failed to fledge chicks, continuing a pattern of even-year breeding failures. These findings highlight differences in response of seabirds to the marine heatwave and the need for continued monitoring at Gull Island to help us understand impacts of possible future changes in the marine ecosystem. Learn more: https://on.doi.gov/3x2iTGU. Data from this work are available at: https://doi.org/10.5066/P961LWWE





TERNS IN TROUBLE?

Aleutian tern numbers have declined dramatically throughout Alaska over the past 40 years. They have been known to nest in Kachemak Bay for a long time, but a former colony near the Homer airport has been abandoned since the late 1990's. A colony near Fritz Creek was more recently home to about 60 pairs of Aleutian terns. In 2020, up to 8 birds were observed prospecting at the Fritz Creek site in May, but no birds were seen from June onward and no breeding was recorded. Similar breeding failures were seen in the previous four years. Aleutian terns were seen in the Bay during August, near the end of the breeding season, which could represent birds from colonies outside the bay, or could hint at a so-far unknown colony in the bay.

Tern Again Consulting

LISTENING FOR KILLER WHALES IN KACHEMAK BAY

Killer whales use unique dialects of recognizable calls that can be used to distinguish populations and often family groups. In August 2020, researchers deployed a hydrophone in outer Kachemak Bay to begin collecting year-round data on the presence of killer whales. Acoustic recordings will show how often killer whales use this area and which populations and pods are present. This information is important to understand top-down forcing on the ecosystem and to support management of this federally protected species. Preliminary results from the first year in Kachemak Bay are expected soon. Learn more: Hannah Myers, hmyers8@alaska.edu

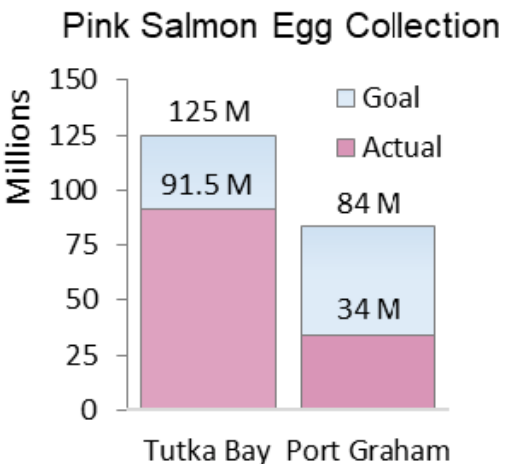
North Gulf Oceanic Society, NOAA permit #20341

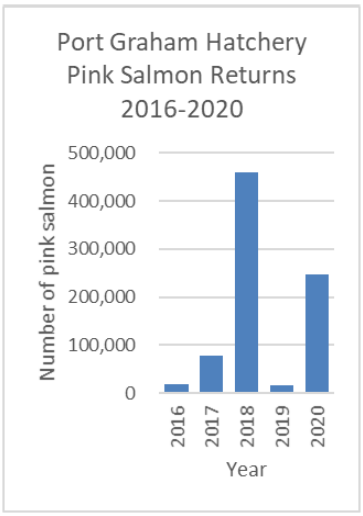
North Gulf Oceanic Society
3430 Main Street Suite B1 Homer, Alaska 99603

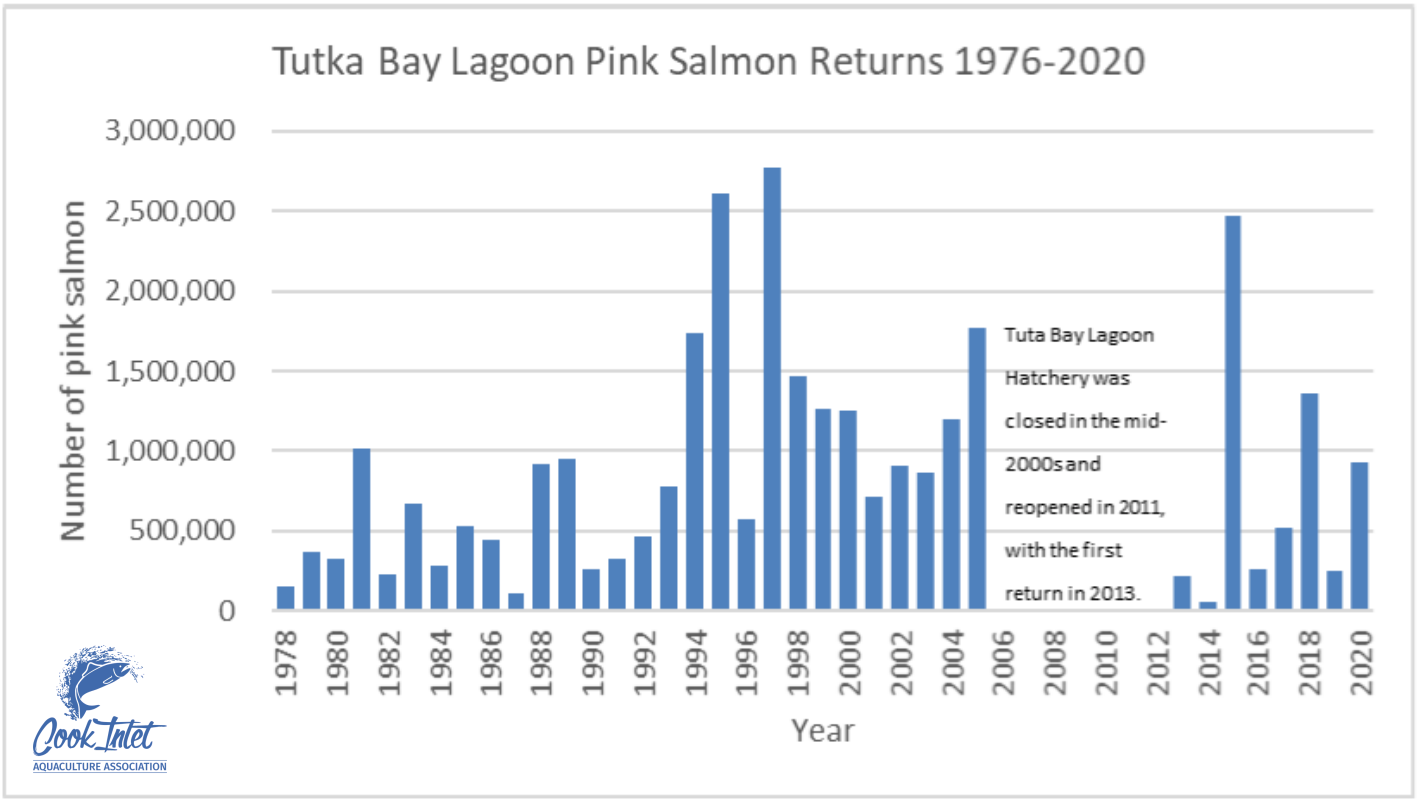
UAF University of Alaska Fairbanks

HATCHERIES HAVE STRONGER PINK SALMON RETURNS IN 2020

Cook Inlet Aquaculture Association (CIAA) operates Tutka Bay Lagoon Hatchery (State of Alaska owned) and Port Graham Hatchery (CIAA owned). In 2020 both hatcheries experienced stronger pink salmon returns than in 2019. Tutka Bay pink salmon returns were 932,800 fish in 2020. Port Graham saw 248,000 pink salmon return in 2020 compared to only 17,500 the previous year. Both hatcheries fell short of egg collection goals again in 2020. Learn more: www.ciaanet.org

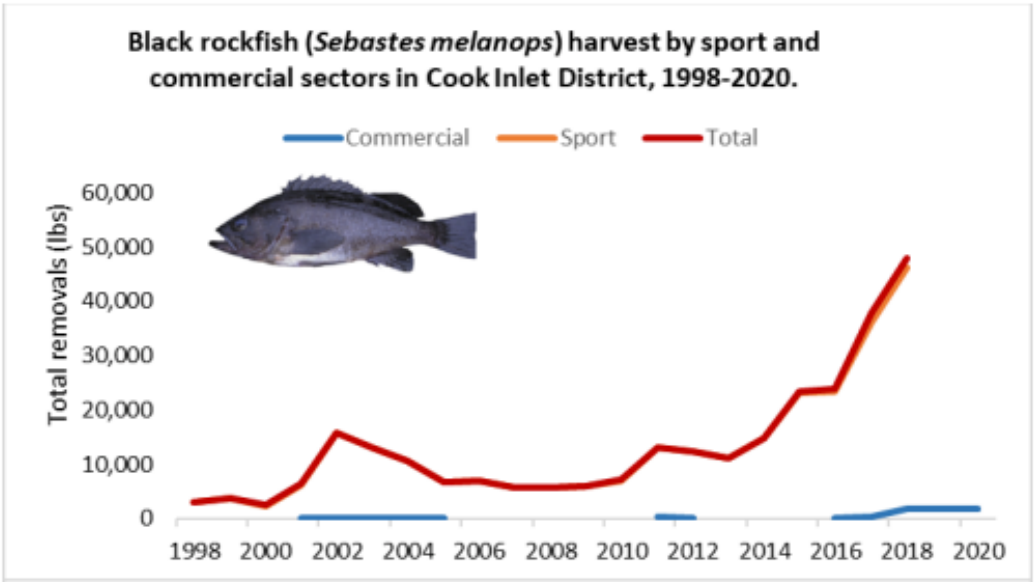


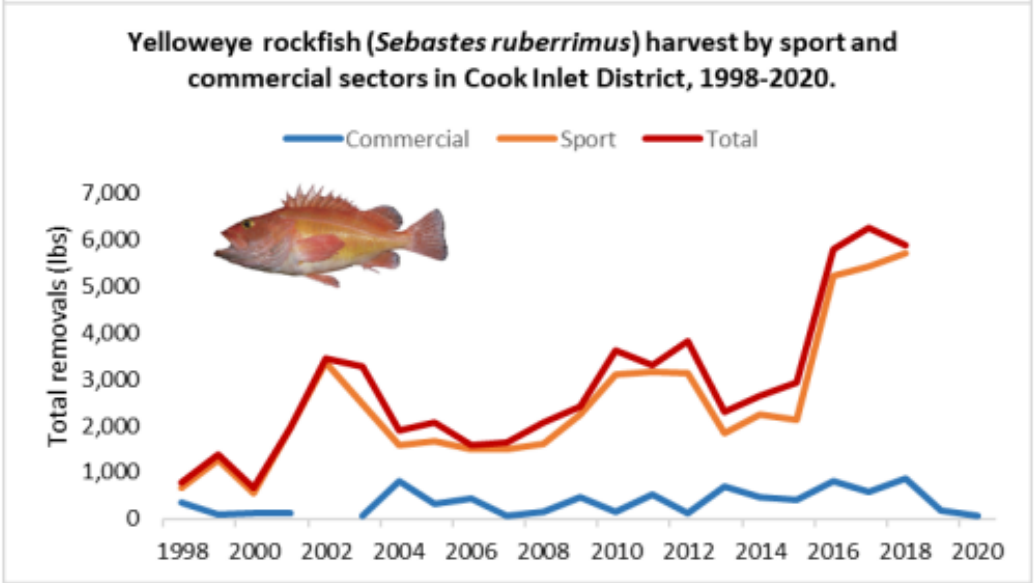




ROCKFISH HARVEST INCREASING

Rockfish harvest in the Gulf of Alaska, including Cook Inlet and Kachemak Bay, is increasing as other popular recreational fisheries become more restricted. Rockfish take many years to mature and can live over 100 years, depending on the species, making them especially vulnerable to overharvest. Alaska Department of Fish and Game's (ADF&G) Statewide Rockfish Initiative is developing long-term management strategies for black and yelloweye rockfish fisheries. Collaborative assessment and management between sport and commercial ADF&G biologists will help ensure that spawning populations and fishing opportunities are maintained under an appropriate harvest level. Learn more: www.adfg.alaska.gov/rockfish





Black and yelloweye harvest from sport and commercial fisheries in the Cook Inlet District, of which the majority is from the sport sector. Data provided by Martin Schuster (ADF&G Sport Fish) and Elisa Russ (ADF&G Commercial Fisheries).

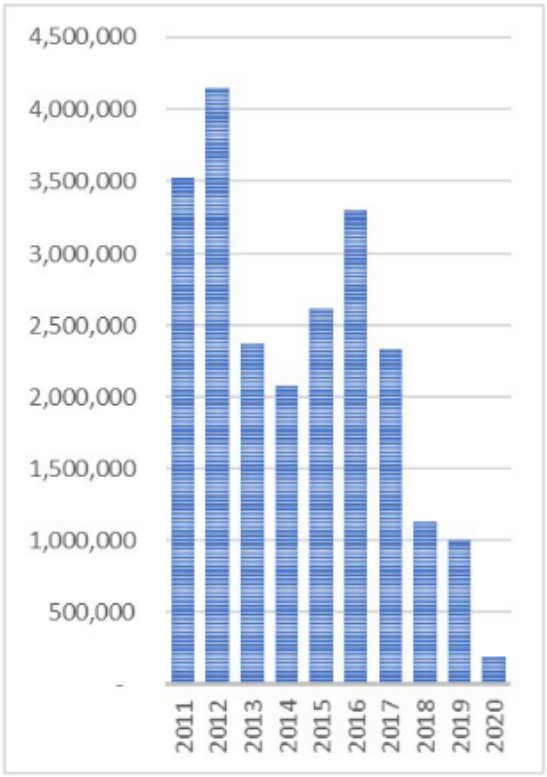
Note: Sport harvest data only available 1999-2019

PACIFIC COD FEDERAL GULF OF ALASKA FISHERY CLOSURE IN 2020

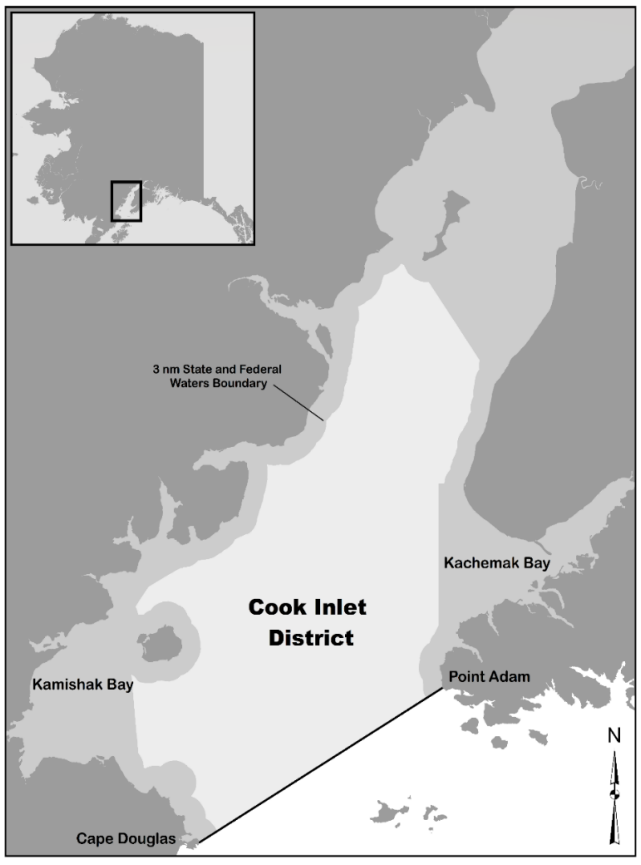
Pacific cod harvest in the Cook Inlet Area has been declining since 2016, and negative impacts on the stock have been linked to climate change, specifically the Pacific marine heatwave in 2014, when young Pacific cod experienced high mortality.

In the Cook Inlet Area, there are three commercial Pacific cod fisheries, the state-waters and parallel seasons in state waters, and a federal waters fishery. The state-waters season is limited to pot and jig gear and the majority of the fleet is based in Homer. The federal and parallel seasons run concurrently and were closed in 2020 after the National Marine Fisheries Service (NMFS) stock assessment in the Gulf of Alaska (GOA) indicated record low numbers of Pacific cod. This was the first closure since the federal fishery has been managed by the North Pacific Fishery Management Council (established in 1976). However, a state-waters season in the Cook Inlet Area did open at a reduced allowable harvest level in 2020.

In late 2020, after NMFS stock assessment indicated the population was recovering, it was announced that the 2021 federal GOA Pacific cod fishery would open; the recovery appears to be supported by preliminary 2021 fishery data. For more information: ADF&G Homer office at (907) 235-8191.



Cook Inlet District Pacific cod harvest (lb) in both state and federal waters. Harvest data provided by Elisa Russ (ADF&G Commercial Fisheries).



The Cook Inlet District includes all waters of Alaska north of a line from Cape Douglas to Point Adam as designated for commercial groundfish fisheries in the Cook Inlet Area (5 AAC 28.305). Map provided by Joe Loboy (ADF&G Commercial Fisheries).

MARINE DEBRIS CLEANUP

The 2020 CoastWalk cleanup organized by the Center for Alaskan Coastal Studies was different from previous years due to Covid-19, both in how it was carried out and who participated. Most schools were unable to participate, leading to fewer cleanup participants. We anticipated debris changes brought on by Covid-19 such as a potential reduction of consumer litter at accessible beaches due to reduced tourism and activity, or increased presence of personal protective equipment (PPE), particularly gloves. However, we did not see evidence of these changes in the fall, with our pounds per person hour staying fairly close to our average and no major changes in overall structure of debris. The largest change was an increase in polystyrene pieces (primarily from deteriorating floating docks), especially when compared to other items. Very few masks were found during the 2020 Coastwalk, but they were a common sight after snow melt in the spring of 2021.
Learn more: https://bit.ly/2Vo8veQ

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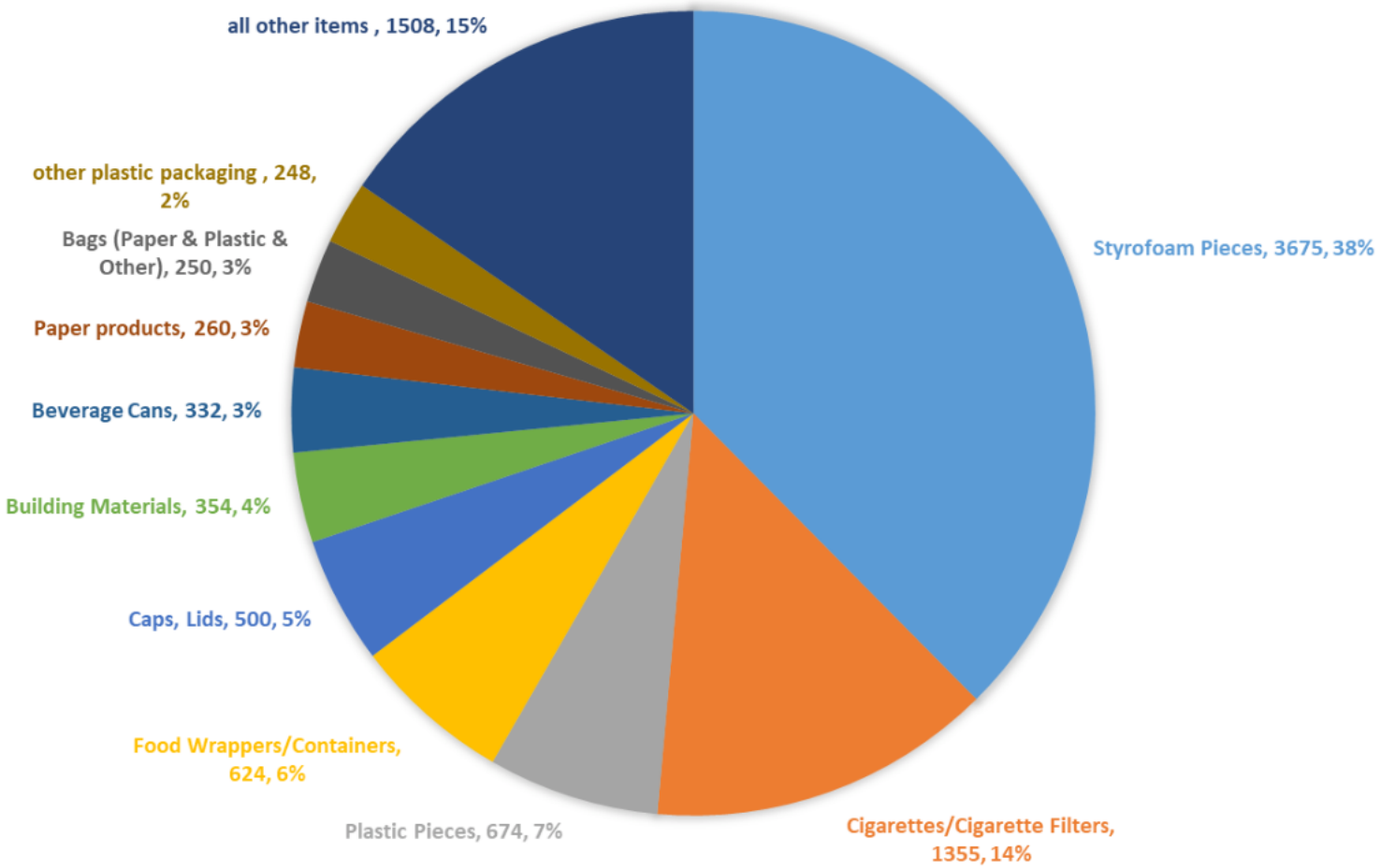
	2020	10 year average	2020 percent average
pounds	860	2082.6	41.3
pounds per person hour	2.33	2.57	90.66

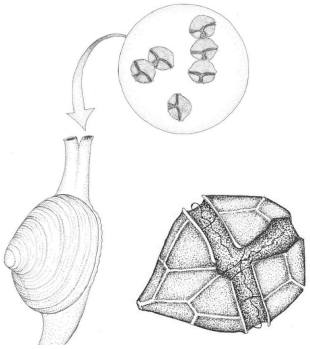
KACHEMAK BAY MARINE DEBRIS 2020



HARMFUL ALGAL BLOOMS (HABS)

Phytoplankton are microscopic plant-like organisms at the base of the marine food-web, an essential part of a healthy marine ecosystem. Over 50 phytoplankton species are commonly found in Kachemak Bay, and and three species produce toxins that can be harmful to people. When these phytoplankton 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 275 phytoplankton samples from 37 locations across Southcentral Alaska in 2020 to monitor for the presence of harmful phytoplankton. NOAA Kasitsna Bay Lab researchers also collected plankton samples during monthly shipboard oceanography surveys across the Bay. In 2020, phytoplankton species of concern were present at least nine months of the year in Kachemak Bay, but testing of wild shellfish never found PSP toxin levels that were above regulatory limits for human consumption.

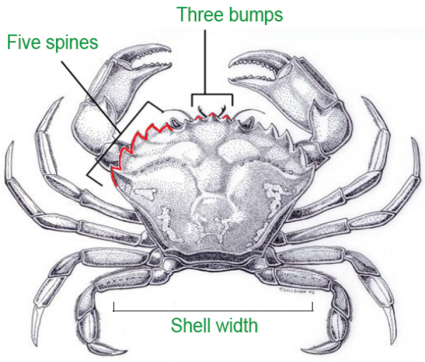


KBNERR's Marine Phytoplankton of Southcentral Alaska guide has been updated to include more species with new illustrations by Conrad Field, including the ones shown here of a phytoplankton and a clam filtering phytoplankton from the water.
The guide can be found online: https://bit.ly/3deIR2d

EUROPEAN GREEN CRAB (EGC)

EGC's are an aggressive invasive species, observed within 90 miles of the Alaskan border with British Columbia on the island of Haida Gwaii.

Early detection is the most effective way to remove invasive species and minimize harmful impacts. In the summer of 2020, five volunteer groups completed 17 trapping events to monitor for European Green Crab and none were found. Look for the **5** spines on the outside of the eyes and the flat "swimming" legs at the back. Their claws are also different sizes with one being smaller than the other. If you want to join our volunteer network for the early detection of EGC email Jasmine at jrmaurer@alaska.edu.



Green crabs can be identified by their unique shell shape. Adults can have shells up to four inches across in width.

European green crab identification from UW Crab Team.

Please report any sightings of potential invasive species to 1-877-INVASIV

NOAA KASITSNA BAY LAB: IMPROVING ACCESS TO COASTAL DATA

Researchers, resource managers, educators, and citizen scientists work hard to track changes in the Bay and we are making this information available in new ways, including through online data viewers, including the following:

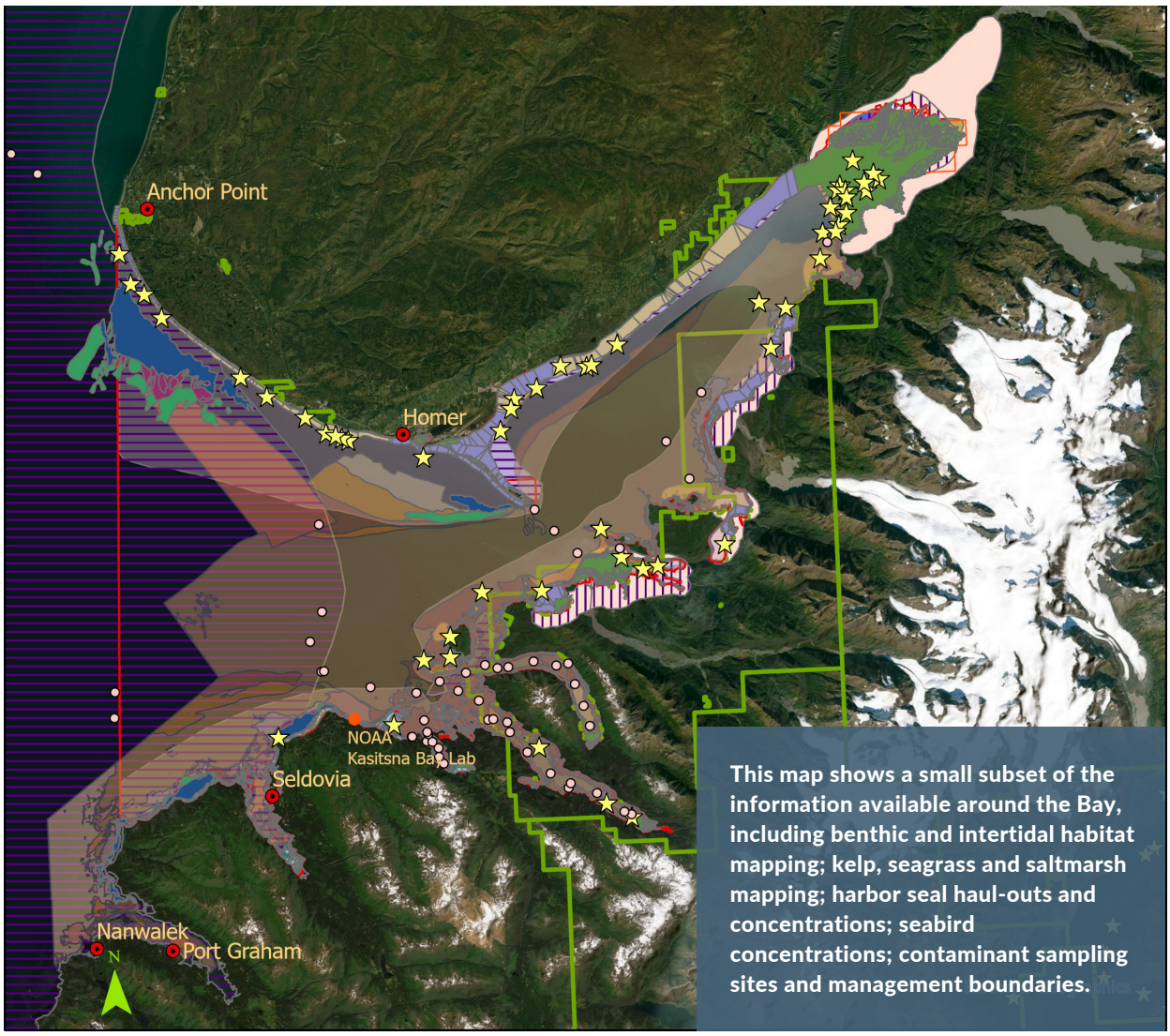
The NOAA NCCOS Kachemak Bay BIOMapper shows many spatial data layers in one place: https://bit.ly/3BTNIjN

The Alaska Ocean Observing System data portal hosts thousands of datasets, including those from the Kachemak Bay Ecological Characterization (Kachemak Bay NERR): https://bit.ly/3yap24k

Stay tuned for upcoming new tools from the NOAA NCCOS Kachemak Bay Ecological Assessment!

NOAA Kasitsna Bay Lab is part of the National Centers for Coastal Ocean Science (NCCOS) under NOAA's National Ocean Service. NCCOS partners with the University of Alaska Fairbanks on lab operations, research and education.

Contact: Kris.Holderied@noaa.gov. **Lab information:** https:/coastalscience.noaa.gov/about/facilities



This map shows a small subset of the information available around the Bay, including benthic and intertidal habitat mapping; kelp, seagrass and saltmarsh mapping; harbor seal haul-outs and concentrations; seabird concentrations; contaminant sampling sites and management boundaries.