Partnering in Search of Answers: Seabird Die-offs in the Bering and Chukchi Seas

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Highlights

- During 2022, the northern Bering and southern Chukchi Sea region reported the sixth consecutive year of higher-than-expected beach-cast seabirds (2017-22).
- Reports of beach-cast carcasses ranged from Point Hope to Izembek Lagoon and numbered ~450, fewer than in the preceding several years but a continued concern for coastal communities.
- Tracking the duration, geographic extent, and magnitude of seabird bird die-offs across Alaska's expansive and remote coastline is only possible through well-coordinated communication and a dedicated network of Tribal, State, Federal, and university academic partners.

Introduction

Prior to 2015, seabird die-offs in Alaskan waters were rare; they typically occurred in mid-winter, linked to epizootic disease events or above-average ocean temperatures associated with strong El Niño-Southern Oscillation events (Bodenstein et al. 2015; Jones et al. 2019; Romano et al. 2020). Since 2015, the U.S. Fish and Wildlife Service (USFWS) has monitored mortality events that have become annual occurrences in Alaska (Fig. 1). Since 2017, communities on the coasts of the northern Bering and southern Chukchi Seas have annually observed dead and dying seabirds along their coasts (Fig. 2). Affected species included birds that consume plankton such as auklets (*Aethia* spp.), plankton and fish consumers such as shearwaters (*Ardenna* spp.) and northern fulmars (*Fulmarus glacialis*), primarily fish-consuming murres (*Uria* spp.), puffins (*Fratercula* spp.), and kittiwakes (*Rissa* spp.), as well as low numbers of benthic feeding sea ducks (*Somateria* spp.) (U.S. Geological Survey 2022). The range of seabird and prey species involved, the timing of these die-offs throughout summer, and the localization of events over widespread areas indicate environmental causes at multiple trophic levels. Such wildlife mortality events are a public health concern for coastal communities that rely on ocean resources for

their nutritional, cultural, and economic well-being. They have also been seen as a harbinger of concern for the state of the Arctic Ocean itself.

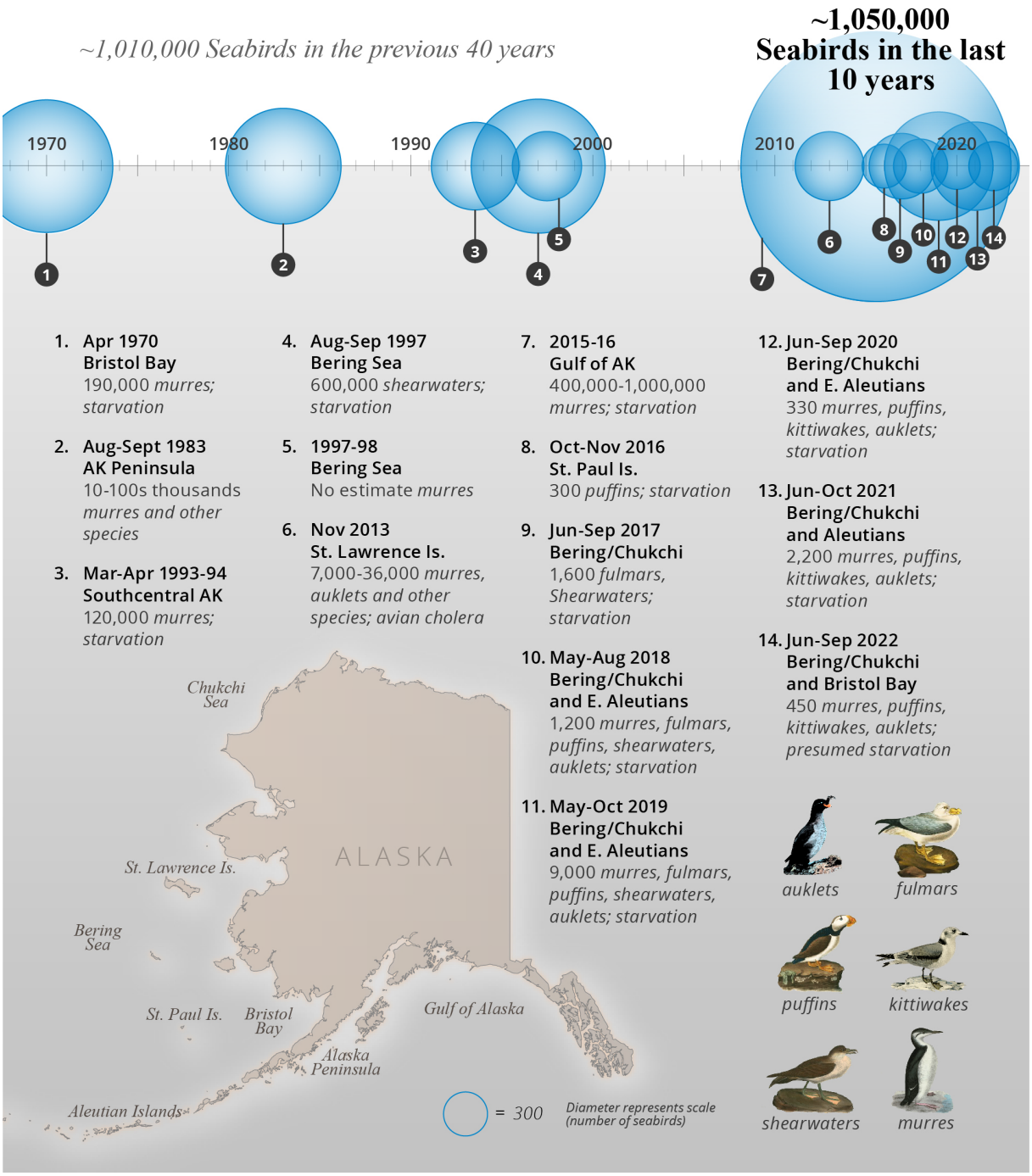

Fig. 1. Alaska seabird die-offs, 1970 to present. Since 2015, mass die-offs have annually occurred in Alaska. Species primarily affected include murres, puffins, auklets, shearwaters, fulmars, and kittiwakes. (Credit: Sarah Battle, NOAA/PMEL; modified original by Robert Kaler)

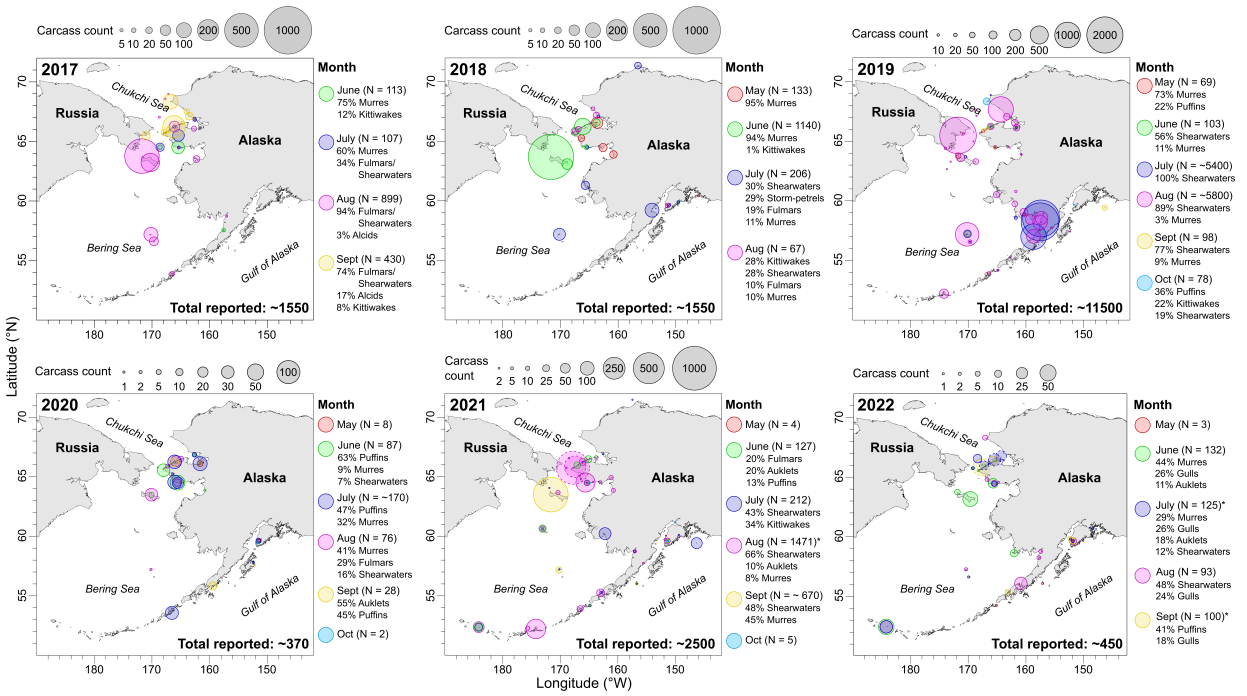

Fig. 2. Alaska seabird mortality records, 2017-22. Size of concentric circles indicates the cumulative count of seabird carcasses reported each month of the corresponding year, aggregated into 100×100 km grid cells overlaid onto the map. Note that locations with no reported carcass counts may result from remoteness and/or lack of visitation or reporting capacity, rather than a lack of seabird carcass deposition. Species/species groups are summarized by month, indicated by color of circle, and percent (%) of total reported (N) each month. Reports courtesy of Tribal, State, and Federal partners.

Seabirds are sentinels of the status of marine ecosystems and these die-offs are concurrent with a massive ecological shift resulting from the loss of sea ice extent and duration in the Bering and Chukchi Seas (Stabeno et al. 2019). Seabirds are top predators, with many consuming forage fish. For example, Pacific sand lance (*Ammodytes hexapterus*), which are a small forage fish found in the nearshore area, are a high-quality prey item, rich in nutrients and calories (Robards et al. 1999). Similarly, Pacific capelin (*Mallotus villosus*) are associated with cold water and are high in nutrients and calories (Montevecchi and Piatt 1984). With increasing ocean temperatures, the numbers of sand lance and capelin have declined, while the numbers of juvenile (Age-0) walleye pollock (*Gadus chalcogrammus*) and Pacific cod (*Gadus macrocephalus*), which are lower quality prey compared to sand lance and capelin, have increased (Duffy-Anderson et al. 2019). Age-0 walleye pollock and its caloric value have been compared to "junk food" (Romano et al. 2006). A drastically increased abundance of Age-0 pollock in warm years (Renner et al. 2016) may compensate for low-energy content of individual fish (Kokubun et al. 2018). Lastly, planktivorous seabirds consume Euphausiids (krill), which are high-value but only locally and seasonally available, and copepods—a group of small crustaceans that vary in size and energy value. As an example of metabolic rate, common murres (*Uria aalge*) are thought to consume 10-30% of their 1050-gram body mass every day, which equates to ~90-300 fish per day (Ainly et al. 2002). While the specific cause of why seabird die-offs have increased in frequency remains largely unknown, the decrease in sea ice extent and lipid-rich ice algae along with warmer ocean conditions are likely involved.

Findings to date, 2017-21

Apparent emaciation was the most significant factor contributing to death based on a combination of field reports, laboratory assessments, and ancillary test results of examined carcasses (Table 1; Bodenstein et al. 2022). Researchers continue to evaluate possible contributing factors. Sample size was limited in 2022, but Highly Pathogenic Avian Influenza (HPAI H5 or H7; see HPAI discussed in *Arctic Geese* essay) has not been confirmed in seabird carcasses except for gulls (*Larus* spp.) and jaegers (*Stercorarius* spp.), which scavenge on carcasses of other birds and mammals. Additionally, H10N6 (a Low Pathogenic Avian Influenza) was detected in two murres samples from St. Lawrence Island in 2018 (Will et al. 2020a).

Table 1. Summary of Bering and Chukchi Seas seabird necropsies, 2017-21. More than 14,000 dead seabirds were reported and a total of 117 carcasses were examined. 92 cases had emaciation identified as the Cause Of Death (COD), seven cases where COD was undetermined, and 17 cases where COD was determined as "Other", which included predation, trauma, encephalitis, peritonitis, and bacterial infection. Low Pathogenic Avian Influenza (n=4) and saxitoxin (n=15) were also detected; however, the virus and biotoxin were not determined to be the COD except for one case in 2020 where saxitoxin toxicosis was suspected.

	2017	2018	2019	2020	2021	Total
Total Reported	>1,600	>1,200	>9,000	>330	>2,200	>14,330
Total Examined	19	25	39	20	14	117
Reported Cause of Death						
Emaciation	17	19	31	13	12	92
Undetermined	0	3	2	1	1	7
Other	2	3	6	6	1	18
Avian Influenza Detected	0	2	0	1	1	4
Saxitoxin Detected	11	BDL*	3	1[&]	BDL*	15

*BDL - Below detection limits for the laboratory test used.
[&]Saxitoxin toxicosis was also suspected to be the cause of death.

Exposure to harmful algal bloom biotoxins (e.g., saxitoxin, associated with paralytic shellfish poisoning) has been detected in seabird tissues in the region, including a puffin from Unalaska Island in 2020. In 2017, saxitoxin was detected in the majority of northern fulmar carcasses collected during a mortality event; however, direct neurotoxic action by saxitoxin could not be confirmed and starvation appeared to be the proximate cause of death (Van Hemert et al. 2021). Little is known about the occurrence of these biotoxins or their impacts on wild seabirds and USGS Alaska Science Center researchers continue investigations (Matthew Smith, USGS, Alaska Science Center, 2022, personal communication).

Beach-cast seabirds continue to be reported over a wide geographic range and throughout summer and fall on an annual basis, albeit at much reduced numbers in some recent years (2020 and 2022). Observations at northern seabird breeding colonies indicate lack of breeding attempts or very late and unsuccessful breeding over several years (Romano et al. 2020; Will et al. 2020b). These observations together with the northward expansion of gadid fishes (Pacific cod, pollock; Duffy-Anderson et al. 2019) suggest that the seabird die-offs stem from a lack of food or unfavorable foraging conditions, indicating

ecosystem changes that may be associated with abnormally high ocean water temperatures (Will et al. 2020a). Additional work is needed to understand links between prey availability and the health and productivity of local seabird populations.

Conclusions

Seabirds and their eggs are an important subsistence food for remote communities in rural Alaska. Rural residents and particularly Alaska Native peoples are concerned about impacts to subsistence food resources. Members of subsistence communities in the northern Bering and southern Chukchi Sea region are frustrated by the lack of timely answers regarding the cause of seabird die-off events and whether birds and eggs are safe to consume. Some communities have requested assistance to document these die-offs and collect samples for testing. The past three years have been especially challenging owing to the global COVID-19 pandemic, which limited abilities to conduct full necropsies on carcasses to determine causes of death, as well as due to increased concerns regarding HPAI in 2022. The USFWS continues to collaborate with numerous partners, including the Alaska Migratory Bird Co-Management Council, Alaska Department of Fish and Game, National Oceanic and Atmospheric Administration, National Park Service, and coastal subsistence communities to monitor and assess seabird die-offs. The USFWS also collaborates with the University of Washington Coastal Observation and Seabird Survey Team, University of Alaska Fairbanks/Alaska Sea Grant Program, University of Alaska Fairbanks Institute for Arctic Biology, USGS (National Wildlife Health Center and Alaska Science Center), and other State and Federal agencies to document and report die-off events.

The next decades will be critical for determining how coastal species and communities in northern Alaska adapt to a fast-changing environment. With Alaska's vast coastline and remote communities, State and Federal agencies lack adequate resources required to investigate changes and document these now annually occurring seabird mortality events. Efforts have led to several lessons learned. Firstly, reports and observations are property; permission must be granted prior to using or sharing observational data and acknowledgment of partner contributions is essential. Secondly, maintaining clear channels of communication, especially regarding shared priorities and mutual expectations, is critical throughout the response process. Thirdly, outreach and information exchange are dynamic, and partners must strive to be consistent, reliable, and inclusive. Lastly, moments of misunderstanding or disagreement provide opportunities for patience and listening. Success begins with small steps.

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