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BIOLOGICAL MONITORING AT EAST AMATULI ISLAND, ALASKA IN 2021

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Key words: Alaska, Barren Islands, black-legged kittiwake, breeding chronology, common murre, East Amatuli Island, fork-tailed storm-petrel, *Fratercula cirrhata,* glaucous-winged gull, Gulf of Alaska, *Larus glaucescens*, *Hydrobates furcatus*, population trend, productivity, *Rissa tridactyla*, tufted puffin, reproductive success, *Uria aalge*

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INTRODUCTION

The Alaska Maritime National Wildlife Refuge (AMNWR) conducts annual ecological monitoring at eight sites throughout Alaska (Figure 1). The objective of this long-term monitoring program is to collect baseline status and trend information for a suite of seabird species representing piscivorous and planktivorous trophic guilds, including key species that serve as indicators of ecosystem health. Members of these guilds include surface-feeders and divers feeding in both nearshore and offshore waters. By comparing the data with environmental conditions and information from other sites, ecosystem processes may be better understood. Data also provide a basis for directing management and research actions, and for assessing effects of management.

East Amatuli Island has been a Refuge-funded annual monitoring site since 2000 (except that monitoring did not occur in 2012 and 2015). Earlier, during 1993-1999, selected seabird species were monitored annually for oil spill damage assessment and recovery by the Refuge with funding from the *Exxon Valdez* Oil Spill Trustee Council (Roseneau et al. 1995, 2000).

Detailed results of 2021 East Amatuli Island monitoring of murres and kittiwakes are contained in this report and are archived at the AMNWR headquarters in Homer, Alaska. Analysis methods for tufted puffin time-lapse images are in development.

This report also contains previous years' monitoring results from the reports *Fork-tailed storm-petrel monitoring at East Amatuli Island, Alaska during 1997-2013* (Kettle 2014), *Black-legged kittiwake monitoring at East Amatuli Island, Alaska during 1993-2014* (Kettle 2016), *Common murre monitoring at East Amatuli Island, Alaska during 1993-2014* (Kettle 2017*b*), and results contained in East Amatuli annual reports from the monitoring years 2014 and 2016-2019 (Kettle et al. 2015, Kettle 2017*a*, Kettle 2018, Kettle 2019, Kettle 2020, Kettle 2021).

STUDY AREA

East Amatuli Island (58°55' N, 152°10' W) is one of the seven Barren Islands, located between the Kodiak archipelago and the Kenai Peninsula (Figures 2 and 3). The Barren Islands range in size from 10 to 2,800 ha, totaling about 4,000 ha. Geologically the islands are a continuation of the Kenai Peninsula and are of mixed origin (mapped in Wilson et al. 2009). They are generally steep and tall, ranging to an elevation of 650 m. Among the 18 species of seabirds that breed on the islands are about 75,000 pairs of fork-tailed storm-petrels (*Hydrobates furcatus*), 25,000 pairs of black-legged kittiwakes (*Rissa tridactyla*), 3,400 pairs of glaucous-winged gulls (*Larus glaucescens*), 60,000 pairs of common murres (*Uria aalge*), and 70,000 pairs of tufted puffins (*Fratercula cirrhata*; Manuwal 1980, Roseneau et al. 2000).

Of the Barren Islands group, East Amatuli (Figure 4) contains the highest seabird abundance. The island provides ledges physically suitable for cliff-nesting birds and substrate for burrow-nesters. While the North American river otter (*Lontra canadensis*) is common across the island group, other mammalian seabird predators, such as the northern red-backed vole (*Myodes rutilus*, present on West Amatuli and Ushagat) and Arctic ground squirrel (*Spermophilus parryii*, present on Ushagat) are absent from East Amatuli.

Most of East Amatuli Island is comprised of steep slopes, with a spine ranging in elevation to 470 m. Lower elevations are dominated by grasses and sedges; higher elevations by crowberry (*Empetrum nigrum*) and other maritime tundra plants.

High marine productivity around the Barren Islands provides seabird foraging habitat. Steep local bathymetry, the location at the entrance to Cook Inlet with its large tides and currents, the surrounding Alaska Coastal Current, and the strong winds of the area are water-mixing factors that contribute to making the Barren Islands prolific for large numbers of breeding seabirds.

METHODS

Personnel

On 15 June 2021 Arthur Kettle, Margi Blanding, Dean Kildaw, and Katey Shedden made a one-day trip from Homer to East Amatuli Island on the chartered M/V *Jackpot* to install time-lapse cameras on the east headland and at Valley Rise. On 16 August the field crew of Arthur Kettle, Sarah Guitart, and Erin Lefkovitz traveled on the Refuge's R/V *Tiĝlax̂* to start the field season. All three field crew participated in data work after the field season.

Field logistics

15 June:	Camera installation trip with charter vessel M/V *Jackpot*.
16 August:	Field camp start via R/V *Tiĝlax̂*.
26 August:	Field crew skiffed to the headlands and changed camera memory cards; photographed cliffnester habitat.
30 August:	Field crew skiffed around the island and obtained another set of cliff-nester habitat photos.
8 September:	Field crew returned to Homer aboard the *Tiĝlax̂*.

Data Collection

Time-lapse cameras: Seven time-lapse cameras monitored murre and kittiwake productivity plots. They were deployed on 15 June on an eastern headland of the island, with views of productivity/population plots used since 1993. The cameras viewed five black-legged kittiwake plots and seven common murre plots. We also installed two time-lapse cameras atop "Valley Rise" (a hill midway down the island's south coast). These cameras viewed tufted puffin habitat and monitored puffins roosting outside their burrows in distant plots. All the camera systems were programmed to record an image every 90 minutes through the end of the breeding season in late September.

On 26 August the field crew skiffed to the east headland to maintain the cameras there and to switch the cameras' memory cards. We also took photos of the island's cliffnester habitat, attempting to obtain quality good enough for counting birds from the images. On 30 August we skiffed around the island, taking photos of the eight "Boat Plots"—large plots that subsample the cliffnester habitat.

In this report breeding data for murres are incomplete. When we switched the memory cards on 26 August, as expected many murres were still incubating eggs. Our intention was to retrieve the cameras (and images from the remainder of the breeding season) with a one-day trip from the mainland sometime after the third week of September—when fledging would be complete. However, we were prevented from doing this because of fieldwork restrictions imposed in September in response to Alaska's COVID-19 conditions. We will include 2021 productivity results for murres in the 2022 report. We do include here counts of adult murres on the productivity plots, as a measure of population trend.

We examined all burrows in eight tufted puffin plots for signs of use and for chicks. We measured all chicks that we could retrieve. We also surveyed all fork-tailed storm-petrel burrows in 11 plots, measuring any chicks found. The storm-petrel chicks were reremeasured twice.

We counted glaucous-winged gull adults and fledglings on the Amatuli Cove beach each morning; these counts are used as a measure of reproductive success for the gull colony atop a nearby 400-m-high ridge.

We mistnetted fork-tailed storm-petrels on four nights in an attempt to collect chick diet samples. Apparently because of the paucity of breeding birds this year, we were able to collect only eight samples. These have not yet been analyzed for content.

On eight days we photographed bill-loads of tufted puffins flying by Valley Rise. We identified (or categorized as "Unknown") 85 prey items in 51 bill-loads.

We offloaded the water temperature loggers in Amatuli Cove, obtaining two years of data since they were not offloaded in 2020.

RESULTS

Results from 2021 and previous years are shown in figures and tables following the narrative. For this annual report, very brief descriptions of results from parameters monitored are given in the narrative; details and analysis have been and will be presented in past and future multi-year reports and other publications.

Common murre

Hatch date: Because we do not yet have the camera memory cards from the second half of the murre breeding season, we are missing data needed to estimate mean hatch date. Results from previous years are shown in Figure 5 and Tables 1 and 2.

Reproductive performance: Because we do not yet have the camera memory cards from the second half of the murres' breeding season, we are missing data needed for reproductive performance results. Results from previous years are shown in Figure 6 and Tables 3, 4, and 5.

Population trend: Adult murres attended productivity plots consistently on plots that retained eggs and intermittently at plots that did not. Counts were similar to those made in 2017-2020, which were in turn lower than in any other previous years with counts (1993-2011 and 2013-2014 [in 2012 and 2015 the plots were not observed, and in 2016 counts were not made because attendance was intermittent on all plots]; Figures 7 and 8; Tables 6 and 7).

Tufted puffin

Reproductive performance: While the number of burrows in the productivity plots declined (see below), the number of chicks per burrow was about average (Figure 10; Tables 9 and 10).

Burrow counts: The number of tufted puffin burrows in the eight plots dropped from the already low counts in 2016-2019; this continued the longer-term decline (Figure 11; Tables 9 and 10). The rest of the island may not reflect this pattern; the decline may be related to the monitoring activities themselves--see Kettle (2021a).

Analysis methods for tufted puffin time-lapse images are in development. From these images we hope to produce data for tracking among-year trends in productivity and population size.

Black-legged kittiwake

Hatch date: Mean kittiwake hatch date was similar to the 23-year average of 13 July for this location (Figure 15, Tables 14 and 15).

Reproductive performance: Compared with previous years, the number of nest-starts in fixed-border plots was about average (Figure 18; Table 19). The number of chicks and fledglings in these plots was fairly low, but not as low as during 2016-2018 (Figure 19, Tables 20 and 21). The ratio of fledglings to nest-starts was about average (Figures 16 and 17; Tables 16-18).

Population trend: The number of adult kittiwakes counted in the productivity plots was below average (Figures 20 and 21, Tables 22 and 23).

Glaucous-winged gull

Our maximum count of glaucous-winged gull fledglings on the Amatuli Cove beach was much higher than in the previous years with counts (2011, 2013-2014, and 2016-2018; Figure 25, Table 27).

Fork-tailed storm-petrel

Reproductive performance: Based on chick weights and the percentage of down remaining on each chick, it appeared that we started fork-tailed storm-petrel surveys well before fledging had started. It appeared that hatching had been very late— at the end of August many chicks were still in the “100 percent” category of remaining down.

In the monitoring plots we found no dead chicks in the burrows, indicating good chick survival. However, the counts of chicks and large chicks were similar to the previous lowest-count years 1998-1999 and 2019 (Figures 26 and 27; Tables 28, and 29). Since burrow counts have been fairly similar across years, the ratios “chicks per burrow” and “large chicks per burrow” reflected the trends in absolute counts of chicks and large chicks (Figures 28 and 29, Table 30.)

Population trend: The number of burrows found in the plots was about average, compared with counts from other years (Figure 30, Table 31).

Chick diet: The mistnet samples have not yet been processed for content analysis.

Sea temperature

The sea temperature in Amatuli Cove during 2021 was relatively cool during the measurement period 1 January to 2 September (Figure 31, Table 32).

OTHER FIELD ACTIVITIES

Dandelion control: A small group of non-native dandelion plants found in 2014 on the valley trail increased in size through the years until we began control efforts this year. We first flagged all plants we could find and then spot-sprayed individual plants with an herbicide. We plan to visit the area during the blooming period next year to see what remains.

ACKNOWLEDGMENTS

Thanks to those who helped with camera deployment (listed in the *Personnel* section). The boat charter company Alaska Coastal Marine brought the camera deployment team to the island in June and the R/V *Tiĝlax̂* brought the field camp crew and gear to and from the island in August-September. The charter and *Tiĝlax̂* teams, along with the headquarters staff, provided excellent support. Lisa Spitler was the contact for our daily field camp check-in. Thanks to all who assisted!

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FIGURES AND TABLES

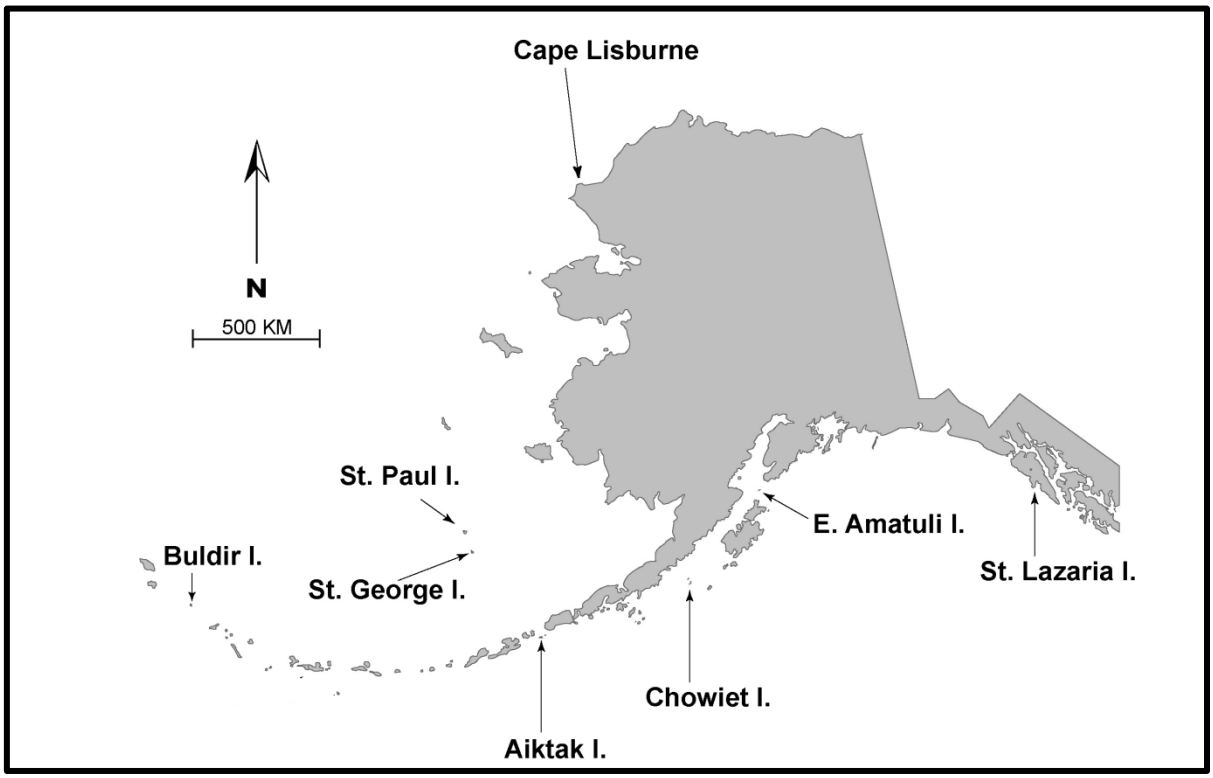

Figure 1. Location of East Amatuli Island and other annual monitoring sites across the Alaska Maritime National Wildlife Refuge.

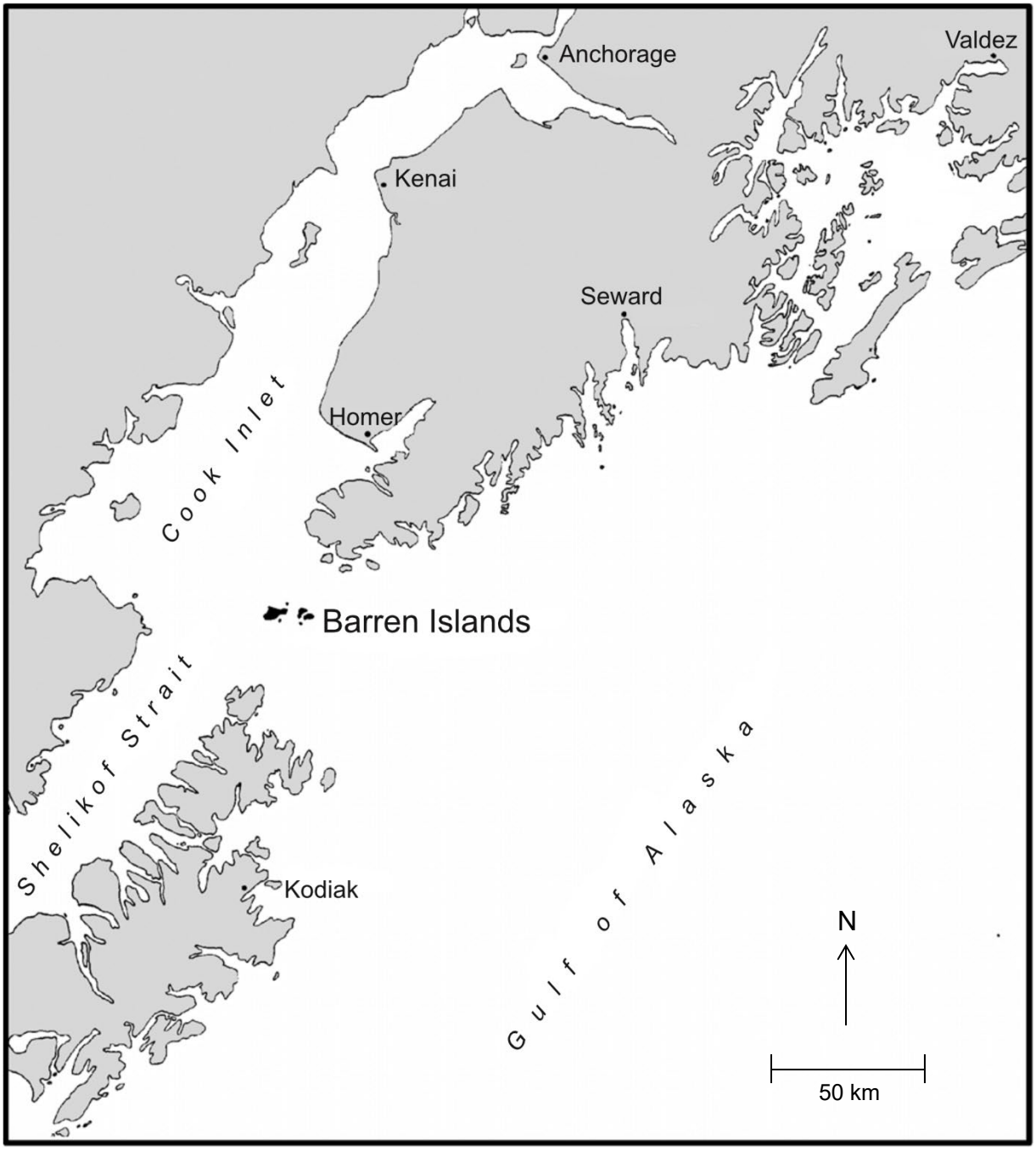

Figure 2. Location of the Barren Islands, Alaska

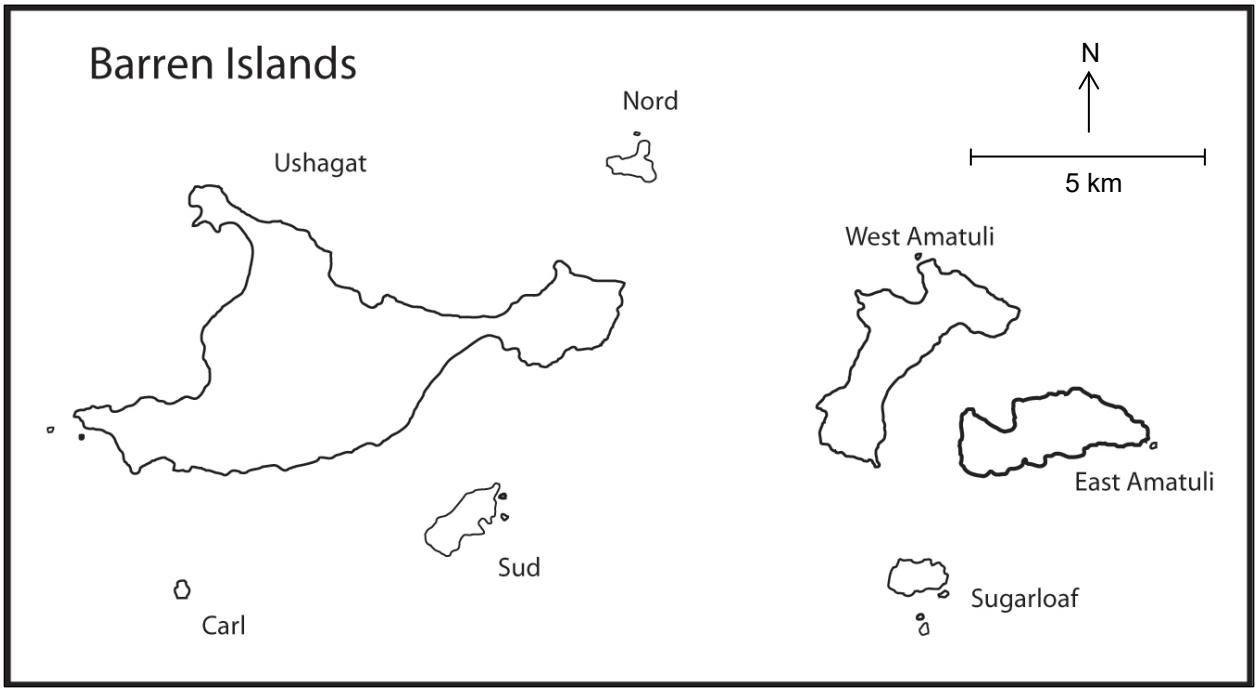

Figure 3. Map of the Barren Islands group.

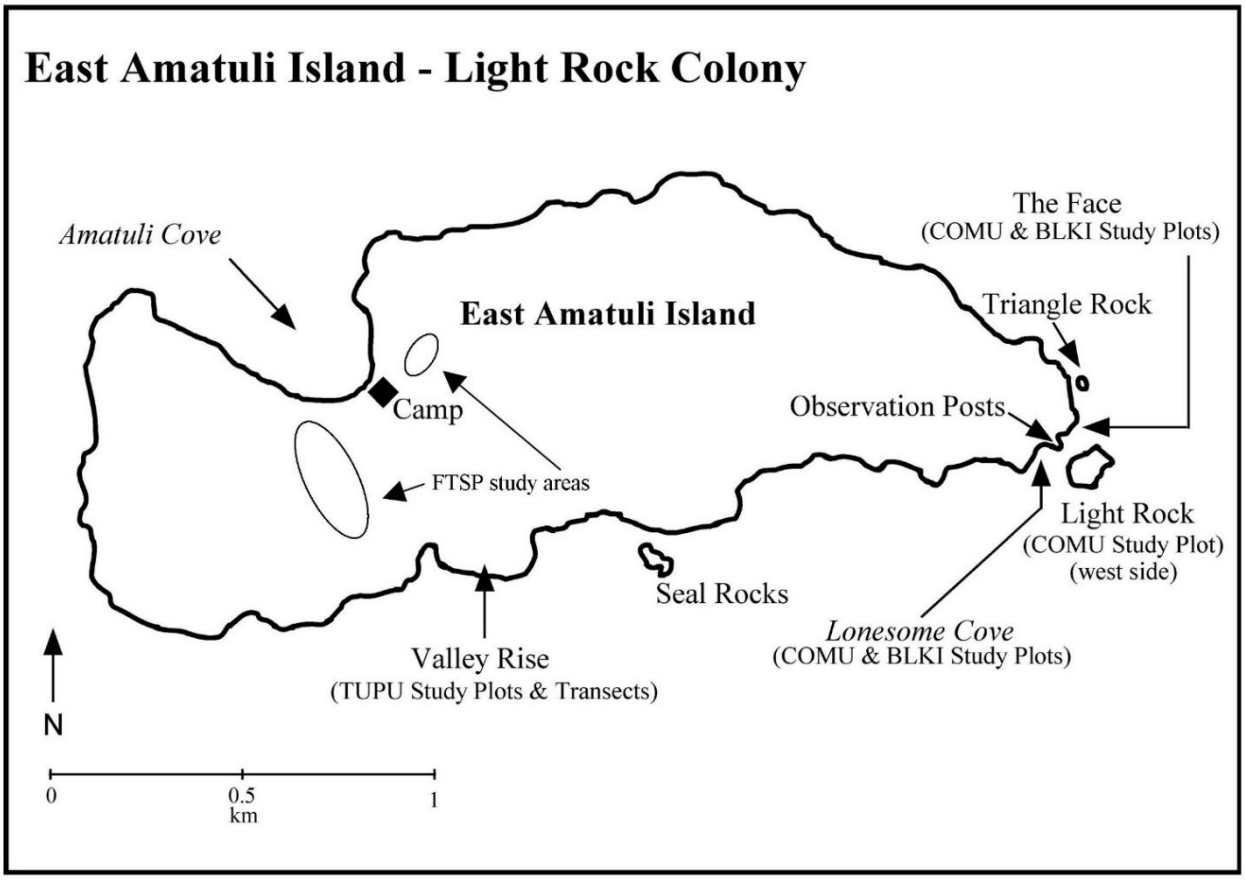

Figure 4. East Amatuli Island, showing locations of common murre (COMU), black-legged kittiwake (BLKI), tufted puffin (TUPU), and fork-tailed storm-petrel (FTSP) monitoring areas.

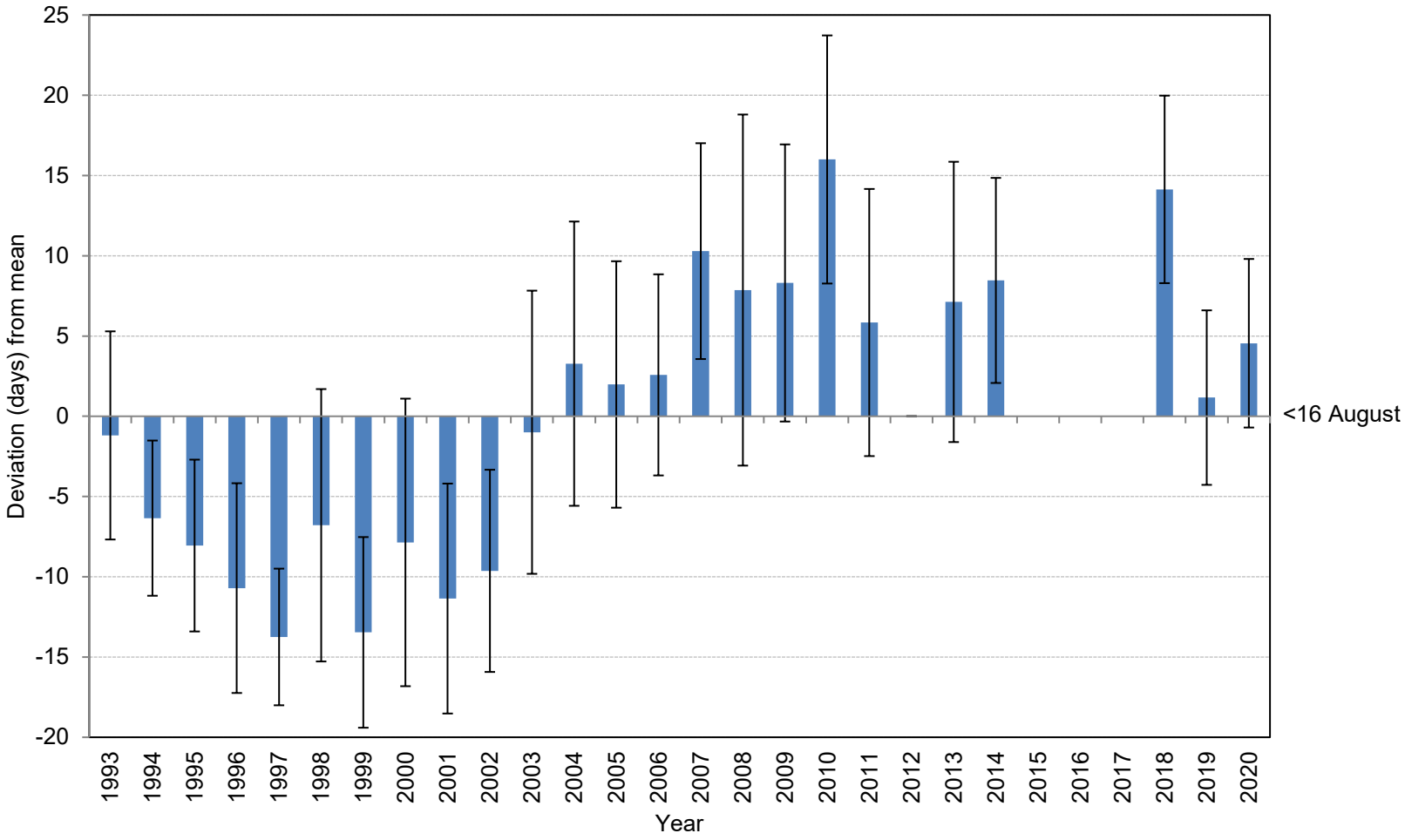

Figure 5. Yearly deviation from the mean (16 August) for hatch dates of common murres at East Amatuli Island, Alaska. For each chick, hatch date was calculated from egg-to-chick observations if possible. Otherwise, for chicks that were seen on the plots for at least 10 days after their plot's mean hatch date, a standard nestling period (21 days) was subtracted from the date of each chick's disappearance from its nest-site. Sample unit = chicks; error bars = one standard deviation. Before 2014, within-year clumping of field observation dates affects measure of error. Blank years: Data were not collected in 2012 or 2015; there were no chicks in the plots in 2016; and in 2017 all chicks hatched were from re-laid eggs (after the first was lost), which are not used for hatch date comparisons. Mean hatch date for 2021 will be calculated when remaining time-lapse camera images are retrieved in 2022.

Table 1. Mean hatch dates of common murres at East Amatuli Island, Alaska, calculated from either (for each chick) (1) egg-to-chick observations, when observations allowed this, or (2) disappearance dates for chicks that were seen for at least 10 days after their plot's mean hatch date. Re-laid eggs are omitted. (See Kettle [2017*b*] for details.) Within years before 2014, irregular field observation intervals cause artificial clumping of hatch date distribution; this affects dispersion values. The sample unit is the nest-site. Results from 2021 will be added when remainineg time-lapse camera images are retrieved in 2022.

Year	Mean hatch	St. dev[a]	*n*
1993	15 Aug	6.5	140
1994	10 Aug	4.8	242
1995	08 Aug	5.4	292
1996	05 Aug	6.5	221
1997	03 Aug	4.3	280
1998	10 Aug	8.5	177
1999	03 Aug	5.9	230
2000	08 Aug	9.0	136
2001	05 Aug	7.2	213
2002	07 Aug	6.3	192
2003	16 Aug	8.8	206
2004	19 Aug	8.9	205
2005	18 Aug	7.7	161
2006	19 Aug	6.3	226
2007	27 Aug	6.7	190
2008	23 Aug	10.9	169
2009	25 Aug	8.6	170
2010	02 Sep	7.7	133
2011	22 Aug	8.3	132
2012[b]	-	-	-
2013	24 Aug	8.7	192
2014	25 Aug	6.4	69
2015[c]	-	-	-
2016[d]	-	-	-
2017[e]	-	-	-
2018	31 Aug	5.8	22
2019	18 Aug	5.4	49
2020	20 Aug	5.3	60
Mean	16 Aug		

[a] "St. dev." = one standard deviation.

[b] No data collected in 2012.

[c] No hatch date data in 2015.

[d] No murre eggs laid in the productivity plots in 2016.

[e] In 2017 only re-laid eggs hatched; re-laid eggs are not used for among-year hatch date comparisons.

Table 2. Frequency distribution of common murre hatch dates calculated from egg-to-chick observations at East Amatuli Island, Alaska. In years before 2014, irregular field observation dates cause artificial clumping of data distribution; afterward, the time-lapse image method reduced this clumping. Included are known cases of nest-sites' second ("re-laid") egg. Hatch-date observations were not made in 2000, 2001, 2012 and 2015. Data from 2021 will be added when remainineg time-lapse camera images are retrieved in 2022.

Date	Year													
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
24 Jul	-	-	-	-	1	-	1	-	-	-	-	-	-	-
25 Jul	-	-	-	2	-	-	5	-	-	-	-	-	-	-
26 Jul	-	-	-	3	-	-	7	-	-	-	-	-	-	-
27 Jul	-	-	-	3	1	-	5	-	-	-	-	-	-	-
28 Jul	-	1	2	10	4	-	10	-	-	-	-	-	-	-
29 Jul	-	-	4	16	3	2	11	-	-	-	-	-	-	-
30 Jul	-	1	2	12	17	3	-	-	-	-	-	-	-	-
31 Jul	-	1	-	11	15	3	56	-	-	2	-	-	-	-
01 Aug	-	-	-	21	61	7	9	-	-	7	5	-	-	-
02 Aug	-	3	24	13	64	17	1	-	-	-	-	-	-	-
03 Aug	-	3	1	17	14	14	37	-	-	32	4	-	-	-
04 Aug	-	10	15	-	23	1	7	-	-	23	2	4	-	-
05 Aug	-	5	13	-	18	15	9	-	-	-	11	4	-	-
06 Aug	-	12	35	39	11	8	14	-	-	-	-	-	1	-
07 Aug	2	34	54	-	31	4	4	-	-	17	12	-	1	2
08 Aug	14	18	23	13	3	22	16	-	-	21	14	-	1	-
09 Aug	-	15	21	3	2	11	2	-	-	-	-	36	3	1
10 Aug	2	29	-	9	-	12	4	-	-	-	-	-	11	-
11 Aug	16	4	16	6	2	10	4	-	-	8	-	-	-	5
12 Aug	10	22	18	-	-	7	3	-	-	9	-	-	-	4
13 Aug	10	24	1	5	-	2	4	-	-	-	-	13	-	7
14 Aug	12	15	-	9	3	2	2	-	-	-	-	1	-	7
15 Aug	5	15	6	4	1	-	11	-	-	1	-	9	-	42
16 Aug	8	11	23	7	-	-	-	-	-	12	-	-	-	-
17 Aug	4	4	12	4	-	1	9	-	-	-	-	-	-	4
18 Aug	3	-	-	7	-	-	-	-	-	-	-	30	-	29
19 Aug	3	8	8	1	-	-	-	-	-	-	34	21	-	23
20 Aug	18	-	2	2	3	7	1	-	-	8	3	-	26	2
21 Aug	1	2	4	-	-	1	1	-	-	6	-	-	-	2
22 Aug	1	1	2	-	-	-	1	-	-	-	35	1	3	21
23 Aug	1	-	1	-	1	16	-	-	-	-	2	-	19	-
24 Aug	2	-	-	-	-	12	-	-	-	-	1	23	-	2
25 Aug	-	-	2	-	-	1	1	-	-	-	20	-	2	18
26 Aug	8	-	-	-	-	8	-	-	-	-	-	-	4	1
27 Aug	1	1	-	-	-	4	1	-	-	-	1	8	6	-
28 Aug	-	-	-	1	2	6	-	-	-	1	-	9	1	9
29 Aug	1	-	-	-	-	-	-	-	-	1	6	6	8	-
30 Aug	1	1	-	-	-	2	-	-	-	-	1	10	1	4
31 Aug	2	-	-	-	-	-	-	-	-	-	-	3	3	8
01 Sep	2	-	-	-	-	1	-	-	-	-	1	-	1	2
02 Sep	-	-	-	-	-	-	-	-	-	-	1	7	-	-
03 Sep	-	-	-	-	-	1	-	-	-	-	-	6	1	4
04 Sep	1	-	-	-	-	-	-	-	-	-	-	-	1	2
05 Sep	-	1	-	-	-	-	-	-	-	-	-	-	-	-
06 Sep	-	-	-	-	-	1	-	-	-	-	-	-	3	-
07 Sep	-	-	-	-	-	-	-	-	-	-	-	2	1	2
08 Sep	1	-	-	-	-	-	-	-	-	-	-	-	-	-
09 Sep	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10 Sep	-	-	-	-	-	-	-	-	-	-	-	1	-	-
11 Sep	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12 Sep	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13 Sep	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14 Sep	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15 Sep	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16 Sep	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17 Sep	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18 Sep	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19 Sep	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 Sep	-	-	-	-	-	-	-	-	-	-	-	-	-	-
n	129	241	289	218	280	201	236	0	0	148	153	194	97	201

Table 2 (year-columns continued). Frequency distribution of common murre hatch dates calculated from egg-to-chick observations at East Amatuli Island, Alaska. In years before 2014, irregular field observation dates cause artificial clumping of data distribution; afterward, use of daily time-lapse photography reduced this clumping. Included are known cases of nest-sites' second ("re-laid") egg. Hatch-date observations were not made in 2000, 2001, 2012 and 2015. Data from 2021 will be added when remainineg time-lapse camera images are retrieved in 2022.

Date	Year													
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
23 Jul	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24 Jul	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25 Jul	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26 Jul	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27 Jul	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28 Jul	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29 Jul	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30 Jul	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31 Jul	-	-	-	-	-	-	-	-	-	-	-	-	-	-
01 Aug	-	-	-	-	-	-	-	-	-	-	-	-	-	-
02 Aug	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03 Aug	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04 Aug	-	1	-	-	-	-	-	-	-	-	-	-	-	-
05 Aug	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06 Aug	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07 Aug	-	4	-	-	1	-	-	-	-	-	-	-	-	-
08 Aug	-	-	1	-	-	-	-	-	-	-	-	-	2	-
09 Aug	-	15	1	1	3	-	-	-	-	-	-	-	1	-
10 Aug	-	-	-	-	3	-	-	-	-	-	-	-	-	-
11 Aug	1	-	-	1	3	-	-	-	-	-	-	-	2	-
12 Aug	-	-	-	-	1	-	-	-	-	-	-	-	3	-
13 Aug	1	16	5	2	1	-	1	-	-	-	-	-	2	-
14 Aug	1	17	4	-	4	-	3	1	-	-	-	-	1	2
15 Aug	4	-	1	-	25	-	4	1	-	-	-	-	3	3
16 Aug	-	-	1	-	2	-	-	-	-	-	-	-	2	2
17 Aug	-	-	-	-	1	-	8	3	-	-	-	-	6	1
18 Aug	3	-	-	1	-	-	5	5	-	-	-	-	7	2
19 Aug	4	9	-	1	1	-	2	6	-	-	-	1	3	6
20 Aug	-	6	-	-	10	-	-	3	-	-	-	-	3	2
21 Aug	-	-	-	-	2	-	13	4	-	-	-	1	1	3
22 Aug	-	2	-	-	2	-	2	3	-	-	-	-	4	5
23 Aug	59	1	-	1	2	-	5	3	-	-	-	1	3	3
24 Aug	1	5	-	2	2	-	16	5	-	-	-	-	-	7
25 Aug	-	3	-	1	-	-	2	1	-	-	-	1	3	2
26 Aug	-	3	-	-	19	-	10	2	-	-	-	1	1	5
27 Aug	26	10	12	7	-	-	11	1	-	-	3	2	-	8
28 Aug	23	6	15	-	1	-	1	2	-	-	-	1	-	2
29 Aug	1	5	-	-	-	-	21	6	-	-	-	-	-	4
30 Aug	1	3	-	-	11	-	-	9	-	-	3	2	-	-
31 Aug	17	-	6	28	6	-	12	2	-	-	3	-	-	1
01 Sep	6	-	6	1	4	-	7	4	-	-	1	-	1	3
02 Sep	5	28	-	4	8	-	3	4	-	-	1	1	-	1
03 Sep	1	-	18	2	6	-	1	2	-	-	-	2	1	2
04 Sep	10	5	13	14	-	-	12	-	-	-	-	3	-	2
05 Sep	-	5	3	17	-	-	8	-	-	-	1	2	1	1
06 Sep	-	-	-	10	3	-	2	1	-	-	-	2	1	-
07 Sep	3	9	1	11	1	-	-	1	-	-	2	1	1	-
08 Sep	6	2	1	3	-	-	3	-	-	-	-	1	-	-
09 Sep	3	5	-	6	-	-	-	1	-	-	-	-	-	1
10 Sep	2	-	-	4	-	-	1	-	-	-	-	-	-	1
11 Sep	2	-	-	-	1	-	-	-	-	-	-	-	-	-
12 Sep	2	-	-	1	-	-	-	-	-	-	-	-	-	-
13 Sep	1	-	-	2	-	-	-	-	-	-	-	-	-	-
14 Sep	-	1	-	-	-	-	-	-	-	-	-	-	1	-
15 Sep	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16 Sep	-	-	-	1	-	-	-	-	-	-	-	-	-	-
17 Sep	-	-	-	1	-	-	-	-	-	-	-	-	-	-
18 Sep	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19 Sep	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 Sep	-	-	-	1	-	-	-	-	-	-	-	-	-	-
n	183	161	88	123	123	0	153	70	0	0	14	22	53	69

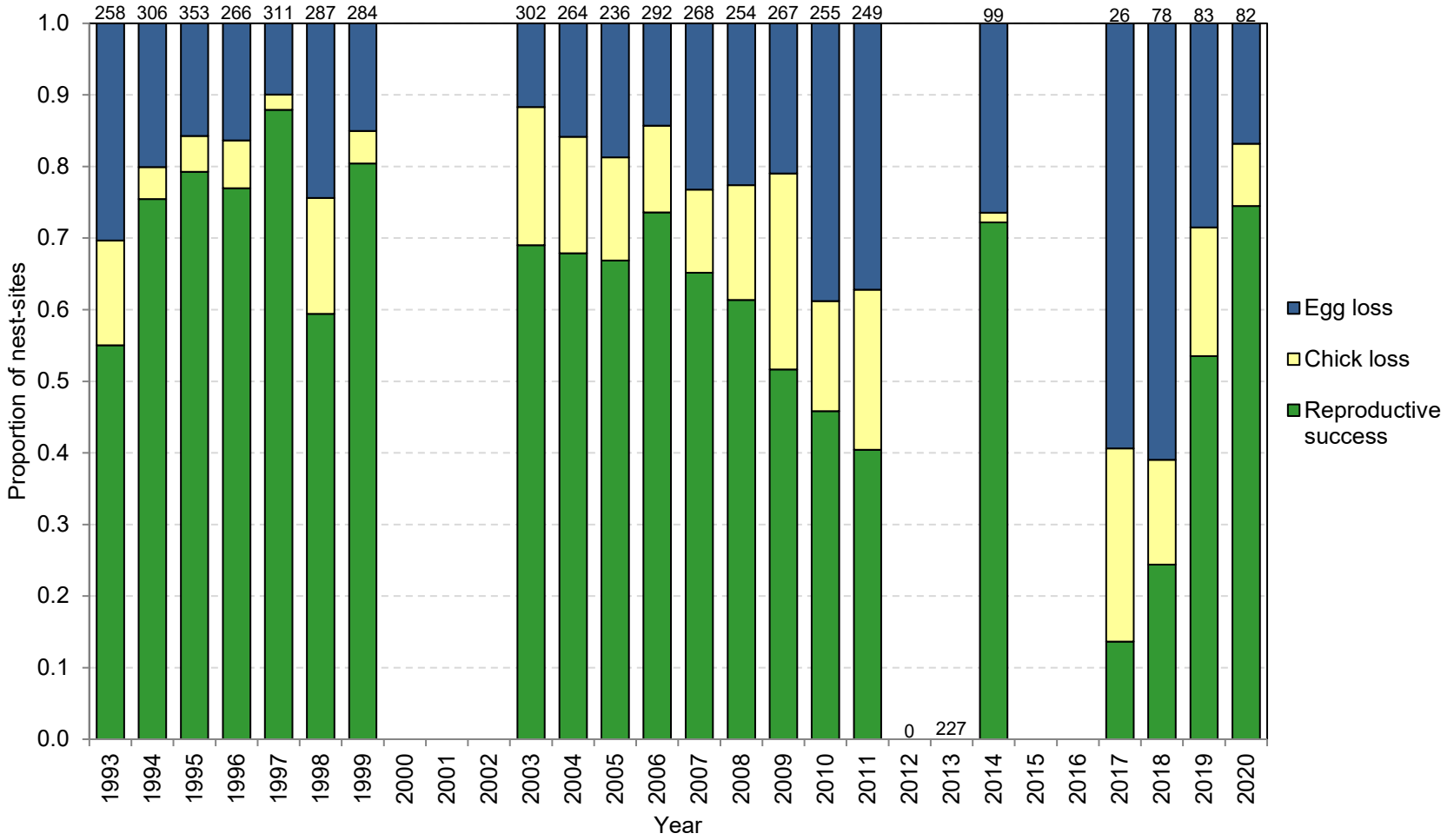

Figure 6. Reproductive performance of common murre nest-sites at East Amatuli Island, Alaska. In this chart a "fledged" chick in the *Chick loss* and *Reproductive success* parameters is defined as a chick seen on its plot at least 10 days after that plot's mean hatch date. From Table 3, Egg Loss = (A-B)/A; Chick Loss = (B-C')/A; Reproductive success=C'/A, where A=nest-sites with eggs; B=nest-sites with chicks; C'=nest-sites with aged chicks "fledged". Numbers above columns indicate nest site sample sizes. Blank years had insufficient or (in 2012) no data for this type of analysis. In 2016 no eggs were laid in the plots. Results for 2021 will be added when remaining time-lapse camera images are retrieved in 2022.

Table 3. Reproductive performance of common murres at East Amatuli Island, Alaska. In years when the monitoring schedule yielded data insufficient for egg counts or chick-ageing, cells requiring these data contain dashes. Data were not collected in 2012. In 2015, observation consisted of a one-day visit to the colony during the nestling period. Results for 2021 will be included when remaining time-lapse camera images are retrieved in 2022.

Year	Number of plots	Sites with an egg or chick seen	Eggs seen (A)	Re-laid egg	Adjusted eggs[a] (A')	Chicks seen (B)	Chicks with prior observed egg	Proportion of chicks w/o prior observed egg	Chicks with hatch date (B')	Proportion of chicks without hatch date	Nest-sites with an aged chick ≥ 15 days old: fledged (C)	Nest-sites with a chick seen ≥ 10 days after plot mean hatch date: "fledged"[b] (C')	Proportion of chicks present at end of season but not yet seen for 10 days after their plot's mean hatch date
1993	9	258	258	0	151.6	176	176	0.00	111	0.37	78	149	0.00
1994	10	306	306	0	300.9	244	244	0.00	240	0.02	218	233	0.00
1995	10	353	353	1	331.2	297	297	0.00	279	0.06	245	282	0.00
1996	10	266	266	13	258.5	222	222	0.00	216	0.03	191	207	0.00
1997	10	311	311	2	308.7	280	280	0.00	278	0.01	255	274	0.00
1998	10	287	240	45	231.5	214	214	0.00	186	0.13	157	178	0.00
1999	10	284	284	12	274.4	241	241	0.00	233	0.03	206	230	0.00
2000	10	255	-	-	-	255	0	1.00	-	1.00	-	38	0.69
2001	10	253	-	-	-	252	0	1.00	-	1.00	-	89	0.20
2002	10	268	215	0	145.8	243	200	0.18	129	0.47	109	216	0.00
2003	10	302	293	0	151.0	258	249	0.03	129	0.50	88	207	0.00
2004	10	264	258	0	197.1	216	210	0.03	165	0.24	127	180	0.00
2005	10	236	234	0	98.4	189	187	0.01	78	0.59	60	161	0.00
2006	10	292	275	0	231.2	235	218	0.07	181	0.23	139	206	0.00
2007	10	268	264	0	172.3	201	197	0.02	133	0.34	96	177	0.00
2008	10	254	243	0	193.9	186	175	0.06	139	0.25	94	155	0.00
2009	10	267	256	0	114.1	199	188	0.06	84	0.58	52	141	0.00
2010	10	255	251	0	160.8	147	143	0.03	92	0.37	63	123	0.00
2011	10	249	249	0	186.1	147	147	0.00	118	0.20	81	111	0.00
2012	-	-	-	-	-	-	-	-	-	-	-	-	-
2013	10	227	185	0	171.8	200	158	0.21	147	0.27	105	159	0.00
2014	3	99	98	1	92.6	72	71	0.01	68	0.06	58	71	0.00
2015	10	-	-	-	-	-	-	-	-	-	0	0	0.00
2016	8	0	0	0	0.0	0	0	0.00	0	0.00	0	0	0.00
2017	5	26	26	5	26	6	6	100	6	0.00	4	4	0.00
2018	7	78	61	7	78	25	25	100	25	0.00	21	21	0.00
2019	7	83	83	6	83	58	58	100	58	0.00	47	47	0.00
2020	7	82	82	12	82	68	68	100	68	0.00	62	62	0.00

(columns continue on next page)

Table 3 (columns continued). Reproductive performance of common murres at East Amatuli Island, Alaska. In years when the monitoring schedule yielded data insufficient for egg counts or chick-ageing, parameter-cells requiring these data contain dashes. Data were not collected in 2012. Results for 2021 will be included when remaining time-lapse camera images are retrieved in 2022.

Year	Chicks/ Eggs (B/A)	"Fledglings"/ Chicks (C'/B)	Fledglings/ Chicks (C/B')	"Fledglings" /Eggs (C'/A)	Fledglings /Eggs (C/A')	Proportion of eggs that didn't hatch: Egg Loss ([A-B]/A)	Proportion of chicks present at end of season but not yet seen for 10 days after their plot's mean hatch date	Proportion of aged chicks that disappeared before fledging (before 15 days old): Chick Loss ([B'-C]/B')	Proportion of chicks that disappeared before "fledging" (before observed 10 days after plot's mean hatch date): "Chick Loss" ([B-C']/B)
1993	0.68	0.85	-	0.58	-	0.32	0.00	0.30	0.15
1994	0.80	0.95	0.89	0.76	0.72	0.20	0.00	0.09	0.05
1995	0.84	0.95	0.82	0.80	0.74	0.16	0.00	0.12	0.05
1996	0.83	0.93	0.86	0.78	0.74	0.17	0.00	0.12	0.07
1997	0.90	0.98	0.91	0.88	0.83	0.10	0.00	0.08	0.02
1998	0.75	0.83	0.73	0.62	0.68	0.25	0.00	0.16	0.17
1999	0.85	0.95	0.85	0.81	0.75	0.15	0.00	0.12	0.05
2000	-	0.15	-	-	-	-	0.69	-	-
2001	-	0.35	-	-	-	-	0.20	-	-
2002	-	0.89	-	-	-	-	0.00	0.16	0.11
2003	0.88	0.80	-	0.71	-	0.12	0.00	0.32	0.20
2004	0.84	0.83	-	0.70	-	0.16	0.00	0.23	0.17
2005	0.81	0.85	-	0.69	-	0.19	0.00	0.23	0.15
2006	0.85	0.88	-	0.75	-	0.15	0.00	0.23	0.12
2007	0.76	0.88	-	0.67	-	0.24	0.00	0.28	0.12
2008	0.77	0.83	-	0.64	-	0.23	0.00	0.32	0.17
2009	0.78	0.71	-	0.55	-	0.22	0.00	0.38	0.29
2010	0.59	0.84	-	0.49	-	0.41	0.00	0.32	0.16
2011	0.59	0.76	-	0.45	-	0.41	0.00	0.31	0.24
2012	-	-	-	-	-	-	-	-	-
2013	-[c]	0.80	-	-	-	-	0.00	0.29	0.21
2014	0.73	0.99	0.81	0.72	0.63	0.27	0.00	0.15	0.01
2015	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-
2016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2017	0.23	0.67	0.67	0.15	0.15	0.77	0.00	0.33	0.33
2018	0.32	0.84	0.84	0.27	0.34	0.68	0.00	0.16	0.16
2019	0.70	0.81	0.81	0.57	0.57	0.30	0.00	0.19	0.19
2020	0.83	0.91	0.91	0.76	0.76	0.17	0.00	0.09	0.09

[a] For years with observations during egg-hatching, "adjusted nest-sites" are raw count of nest-sites, minus nest-sites with a large observation data gap around chick-hatching, minus a proportion of nest-sites without chicks equal to the proportion of chick-nest-sites that were dropped because of their hatch-date gap. It is this adjusted number of nest-sites that is used as the divisor for ratios with numerators of aged fledglings.

[b] "Fledged" in quotes is based on chicks disappearing late in the season, rather than on ageing from hatch dates. For details, see Kettle (2017b).

[c] In 2013 more than 15 percent of the chicks sighted did not have previous egg-sightings—so we have not calculated hatching success.

Table 4. Ratio reproductive performance parameters for common murres at East Amatuli Island, Alaska. In years when the monitoring schedule yielded data insufficient for egg counts or chick-ageing, cells requiring these data contain dashes. Data were not collected in 2012. These data are from Table 3, reproduced here to match a standard Refuge table format. Results for 2021 will be included when remaining time-lapse camera images are retrieved in 2022.

Year	No. plots	Nest-sites with eggs	Nesting success (chicks/eggs)	Fledging success (fledglings/chicks)	Reproductive success (fledglings/nest-sites)	"Fledging success" ("fledglings"[a]/chicks)	"Reproductive success" ("fledglings"/nest-sites)
1993	9	258	0.68	-	-	0.85	0.58
1994	10	306	0.80	0.89	0.72	0.95	0.76
1995	10	353	0.84	0.82	0.74	0.95	0.80
1996	10	266	0.83	0.86	0.74	0.93	0.78
1997	10	311	0.90	0.91	0.83	0.98	0.88
1998	10	287	0.75	0.73	0.68	0.83	0.62
1999	10	284	0.85	0.85	0.75	0.95	0.81
2000	10	255	-	-	-	0.15	-
2001	10	253	-	-	-	0.35	-
2002	10	268	-	-	-	0.89	-
2003	10	302	0.88	-	-	0.80	0.71
2004	10	264	0.84	-	-	0.83	0.70
2005	10	236	0.81	-	-	0.85	0.69
2006	10	292	0.85	-	-	0.88	0.75
2007	10	268	0.76	-	-	0.88	0.67
2008	10	254	0.77	-	-	0.83	0.64
2009	10	267	0.78	-	-	0.71	0.55
2010	10	255	0.59	-	-	0.84	0.49
2011	10	249	0.59	-	-	0.76	0.45
2012	-	-	-	-	-	-	-
2013	10	227	-	-	-	0.80	-
2014	3	99	0.73	0.81	0.63	0.99	0.72
2015	10	-	0.00	0.00	0.00	0.00	0.00
2016	8	0	0.00	0.00	0.00	0.00	0.00
2017	5	26	0.23	0.67	0.15	0.67	0.15
2018	7	78	0.32	0.84	0.34	0.84	0.27
2019	7	83	0.70	0.81	0.57	0.81	0.57
2020	7	82	0.83	0.91	0.76	0.91	0.76

[a] Fledglings" in quotes are based on chicks disappearing late in the season, rather than on ageing from hatch dates. For details, see Kettle (2017b).

Table 5. Standard deviation in reproductive performance ratio parameters of common murres at East Amatuli Island, Alaska. Calculated with a ratio estimator (Ackerman et al. 1987). In years when the monitoring schedule yielded data insufficient for egg counts or chick-ageing, parameter-cells requiring these data contain dashes. Data were not collected in 2012. Results for 2021 will be included when remaining time-lapse camera images are retrieved in 2022.

Year	No. plots	Nest-sites with eggs	Sampling design	Nesting success (chicks/eggs)	Fledging success (fledglings/chicks)	Reproductive success (fledglings/eggs)	"Fledging success" (c_10 "fledglings"/chicks)	"Reproductive success" (c_10 "fledglings"/eggs)
1993	9	241	Cluster by plot	0.05	0.04	0.05	0.03	0.06
1994	10	306	Cluster by plot	0.02	0.03	0.03	0.01	0.02
1995	10	353	Cluster by plot	0.02	0.02	0.03	0.01	0.03
1996	10	266	Cluster by plot	0.03	0.02	0.03	0.01	0.03
1997	10	311	Cluster by plot	0.03	0.02	0.03	0.01	0.03
1998	10	240	Cluster by plot	0.04	0.07	0.08	0.06	0.08
1999	10	284	Cluster by plot	0.03	0.03	0.03	0.01	0.03
2000	10	-	Cluster by plot	-	-	-	-	-
2001	10	-	Cluster by plot	-	-	-	-	-
2002	10	215	Cluster by plot	0.08	-	-	0.02	0.08
2003	10	293	Cluster by plot	0.02	-	-	0.03	0.03
2004	10	258	Cluster by plot	0.06	-	-	0.04	0.06
2005	10	234	Cluster by plot	0.04	-	-	0.02	0.04
2006	10	275	Cluster by plot	0.05	-	-	0.02	0.05
2007	10	264	Cluster by plot	0.03	-	-	0.03	0.04
2008	10	243	Cluster by plot	0.04	-	-	0.04	0.04
2009	10	256	Cluster by plot	0.03	-	-	0.07	0.06
2010	10	251	Cluster by plot	0.04	-	-	0.03	0.04
2011	10	249	Cluster by plot	0.05	-	-	0.03	0.06
2012	-	-	-	-	-	-	-	-
2013	10	172	Cluster by plot	0.04	-	-	0.04	-
2014	3	98	Cluster by plot	0.06	0.05	0.08	0.03	0.10
2015	10	-	Cluster by plot	-	-	-	-	-
2016	8	0	Cluster by plot	-	-	-	-	-
2017	5	26	Cluster by plot	0.19	0.00	0.13	0.00	0.13
2018	7	78	Cluster by plot	0.18	0.06	0.17	0.06	0.17
2019	7	83	Cluster by plot	0.18	0.06	0.06	0.06	0.06
2020	7	82	Cluster by plot	0.04	0.06	0.07	0.06	0.07

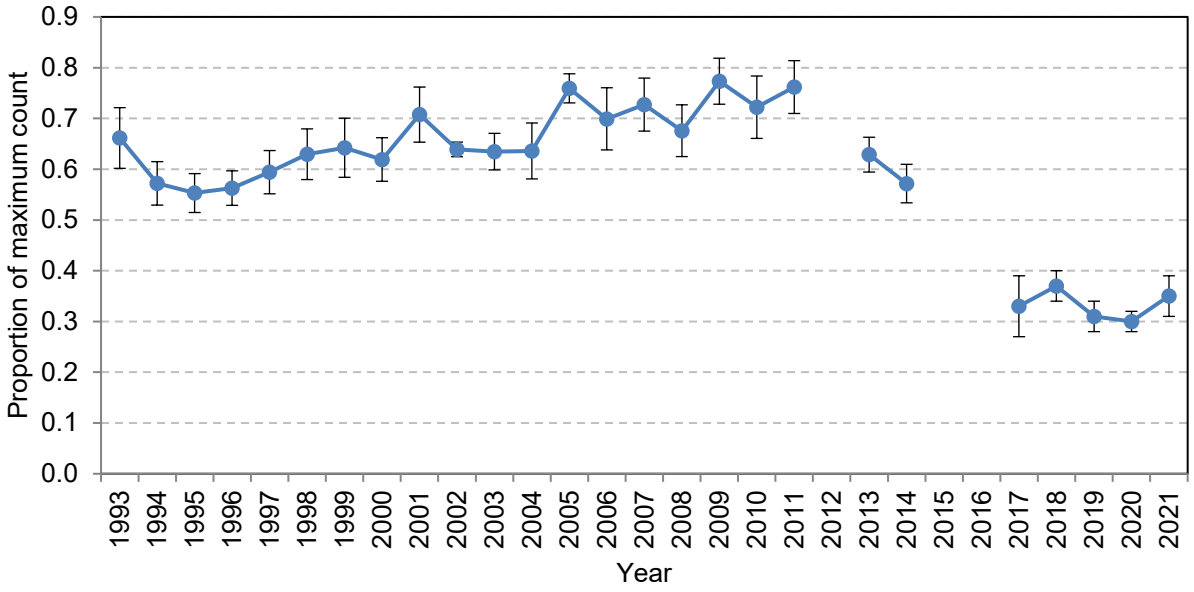

Figure 7. Annual index of counts of adult common murres in productivity plots at East Amatuli Island, Alaska. The index for each year was calculated this way: (1) For each count-day (within the "census period" for that year), counts made that day were summed across all plots counted; (2) that sum was divided by the sum of the among-year maximum counts for those plots; (3) the resulting among-count-day proportion-of-maximum values were averaged for the year. Error bars show one standard deviation from the mean of each year's count-day values. The index values are listed in the "Total" column of Table 6. This "proportion of maximum" method of comparing plot sums was used to maximize data inclusion when occasionally a plot was not counted. There was no field season in 2012 and 2015; in 2016 counts were not made because murre attendance was intermittent on all plots.

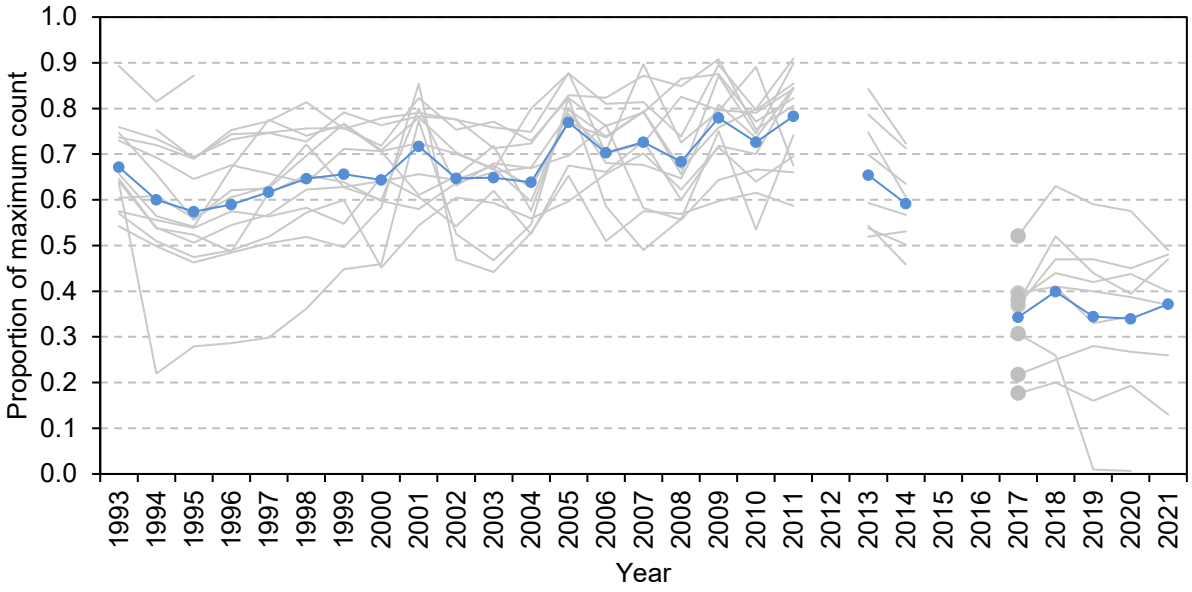

Figure 8. Counts of adult common murres in productivity plots at East Amatuli Island, Alaska. Each grey line connects the annual values for one of the 14 plots. These values were calculated by dividing a plot's mean count for the year by the among-year maximum count for that plot. The blue line shows the among-plot means of these annual values. The plot values are listed in the "Plot" columns of Table 6. This "proportion of maximum" method of comparing plot sums was used to maximize data inclusion when occasionally a plot was not counted. There was no field season in 2012 and 2015; in 2016 counts were not made because murre attendance was intermittent on all plots.

Table 6. Proportion-of-maximum-count of adult common murres in productivity plots at East Amatuli Island, Alaska. Each "Plot" value was calculated by dividing the mean of all counts for that plot that year by the among-year maximum count for that plot. The "Total" column was not calculated from these "Plot" numbers. Instead, within each year, for each day counts were made: (1) the counts across all plots counted that day were summed; (2) the among-year maxima for those plots were summed; and (3) the plot-counts sum was divided by the maxima-sum to obtain the proportion-of-maxima for the sum that day. The average of this value across days was the "Total" value for that year. All counts were restricted to each year's "census period"—between mid-incubation and the first-fledge date. Dashes indicate that data were not collected. This "proportion of maximum" method was used to maximize data inclusion when occasionally a plot was not counted. There was no field season in 2012 and 2015; in 2016 counts were not made because murre attendance was intermittent on all plots.

Year	Plot[a]														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1993	0.64	0.57	0.54	0.64	0.89	0.60	0.73	0.58	0.76	0.74	0.66	0.75	0.65	-	0.66
1994	0.54	0.51	0.50	0.22	0.82	0.61	0.69	0.56	0.73	0.72	0.56	0.66	0.54	0.75	0.57
1995	0.52	0.47	0.46	0.28	0.87	0.56	0.65	0.54	0.69	0.69	0.54	0.56	0.51	0.69	0.55
1996	0.49	0.49	0.48	0.29	-	0.61	0.68	0.58	0.73	0.75	0.67	0.62	0.54	0.74	0.56
1997	0.61	0.52	0.51	0.30	-	0.63	0.66	0.56	0.75	0.77	0.78	0.63	0.57	0.75	0.59
1998	0.65	0.57	0.52	0.36	-	0.72	0.64	0.58	0.73	0.81	0.74	0.70	0.62	0.76	0.63
1999	0.64	0.60	0.50	0.45	-	0.63	0.71	0.55	0.79	0.76	0.76	0.77	0.63	0.76	0.64
2000	0.60	0.45	0.58	0.46	-	0.60	0.71	0.65	0.76	0.78	0.71	0.71	0.64	0.72	0.62
2001	0.58	0.54	0.85	0.77	-	0.80	0.72	0.61	0.78	0.79	0.61	0.78	0.66	0.82	0.71
2002	0.64	0.61	0.47	0.53	-	0.63	0.70	0.54	0.78	0.78	0.65	0.70	0.64	0.75	0.64
2003	0.66	0.59	0.44	0.47	-	0.68	0.67	0.62	0.71	0.76	0.72	0.67	0.68	0.77	0.63
2004	0.67	0.56	0.53	0.55	-	0.67	0.60	0.53	0.72	0.75	0.58	0.80	0.63	0.73	0.64
2005	0.79	0.60	0.65	0.82	-	0.70	0.80	0.68	0.83	0.88	0.80	0.88	0.77	0.82	0.76
2006	0.71	0.66	0.51	0.59	-	0.76	0.74	0.66	0.82	0.70	0.68	0.81	0.74	0.76	0.70
2007	0.90	0.70	0.57	0.49	-	0.58	0.79	0.73	0.87	0.72	0.68	0.81	0.79	0.79	0.73
2008	0.73	0.62	0.57	0.56	-	0.56	0.67	0.60	0.85	0.83	0.65	0.74	0.66	0.86	0.68
2009	0.79	0.71	0.60	0.75	-	0.64	0.76	0.72	0.91	0.80	0.81	0.90	0.87	0.88	0.77
2010	0.89	0.64	0.62	0.53	-	0.67	0.80	0.70	0.75	0.79	0.74	0.80	0.74	0.77	0.72
2011	0.67	0.70	0.59	0.74	-	0.66	0.91	0.84	0.81	0.84	0.85	0.85	0.90	0.82	0.76
2012	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2013	0.54	0.52	0.54	0.59	-	0.44	0.84	0.75	0.71	0.74	0.63	0.71	0.70	0.79	0.63
2014	0.50	0.53	0.46	0.57	-	-	0.72	0.61	-	-	-	-	0.64	0.71	0.57
2015	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2017	0.31	-	0.22	0.18	-	-	0.37	0.40	0.38	-	-	-	0.37	0.52	0.33
2018	0.26	0.41	0.26	0.20	-	-	0.52	0.41	0.44	-	-	-	0.47	0.63	0.37
2019	0.01	0.33	0.28	0.16	-	-	0.44	0.40	0.42	-	-	-	0.47	0.59	0.31
2020	0.01	0.35	0.27	0.19	-	-	0.39	0.39	0.44	-	-	-	0.45	0.58	0.30
2021	-	-	0.24	0.13	-	-	0.47	0.37	0.40	-	-	-	0.48	0.49	0.35

[a] Counting plots 1-14 have respective field names M1-LC, M2-LC-93+A, M3-LC, TB1-LC, M4-LC, M5-LR, M1-F, M1-F-A, M2-F, M3-F, M3-F-A, M4-F, M5-F, and M5-F-A.

Table 7. Counts of adult common murres on productivity plots at East Amatuli Island, Alaska in 2020. Shown are (1) each daily count for each plot counted, (2) the among-day within-"census period" mean count for each plot, (3) the among-year maximum count for that plot, (4) the sum of count-plots for each day, (5) the sum of among-year maximum counts for the plots counted that day, (6) the day's sum divided by this sum-of-maxima, and (7) the census-period mean for those proportion-of-maximum-sums. The mean count for each plot divided by its among-year maximum count was used to construct Table 6 and the grey lines in Figure 8. The mean proportion-of-maximum-sum is the mean point used in that figure and in Figure 7; the standard deviation in Figure 7 is calculated from the proportion-of-maximum-sums. This "proportion of maximum" method of comparing plots sums was used to maximize data inclusion when occasionally a plot was not counted.

	Plot[a]														Sum of	Sum of	Counts/
Date[d]	1	2	3[d]	4	5	6	7	8	9	10	11	12	13	14	counts	maxima[b]	maxima[c]
19-Jul-21	12[e]	-	0	4	-	-	30	16	31	-	-	-	25	27	145	557	0.26
24-Jul-21	-	-	21	13	-	-	32	15	32	-	-	-	32	23	147	372	0.40
29-Jul-21	-	-	26	13	-	-	26	13	34	-	-	-	33	25	170	444	0.38
4-Aug-21	-	-	26	12	-	-	23	15	33	-	-	-	27	23	133	372	0.36
9-Aug-21	-	-	24	10	-	-	27	13	25	-	-	-	33	18	150	444	0.34
14-Aug-21	-	-	18	13	-	-	27	15	33	-	-	-	32	24	144	372	0.39
19-Aug-21	-	-	17	11	-	-	26	16	29	-	-	-	31	26	139	372	0.37
25-Aug-21	-	-	19	14	-	-	28	15	28	-	-	-	33	24	161	444	0.36
Mean during census period (18 Jul-26 Aug):	-	-	18.9	11.3	-	-	27.4	14.8	30.6	-	-	-	30.8	23.8	-	Mean:	0.35
Among-year maximum count:	113	-	72	86	-	-	58	40	76	-	-	-	64	48	-	St. dev.:	0.04
Plot mean proportion of maximum:	-	-	0.26	0.13	-	-	0.47	0.37	0.40	-	-	-	0.48	0.49	-	-	-

[a] Counting plots 1-14 have respective field names M1-LC, M2-LC-93, M3-LC, TB1-LC, M4-LC, M5-LR, M1-F, M1-F-A, M2-F, M3-F, M3-F-A, M4-F, M5-F, and M5-F-A.
[b] Among-year maximum count for the plots counted this day.
[c] Sum of plot counts for this replicate, divided by the among-year maximum count sum for the same plots, if ≥ 4 plots counted.
[d] The camera for Plot 3 intermittently failed to record images on some days. For Plot 3, the following count-dates were substituted for those listed in the table: 25 July for 24 July; 2 August for 4 August; 17 August for 14 August; 23 August for 19 August.
[e] The camera for Plot 1 failed after the first count-date.

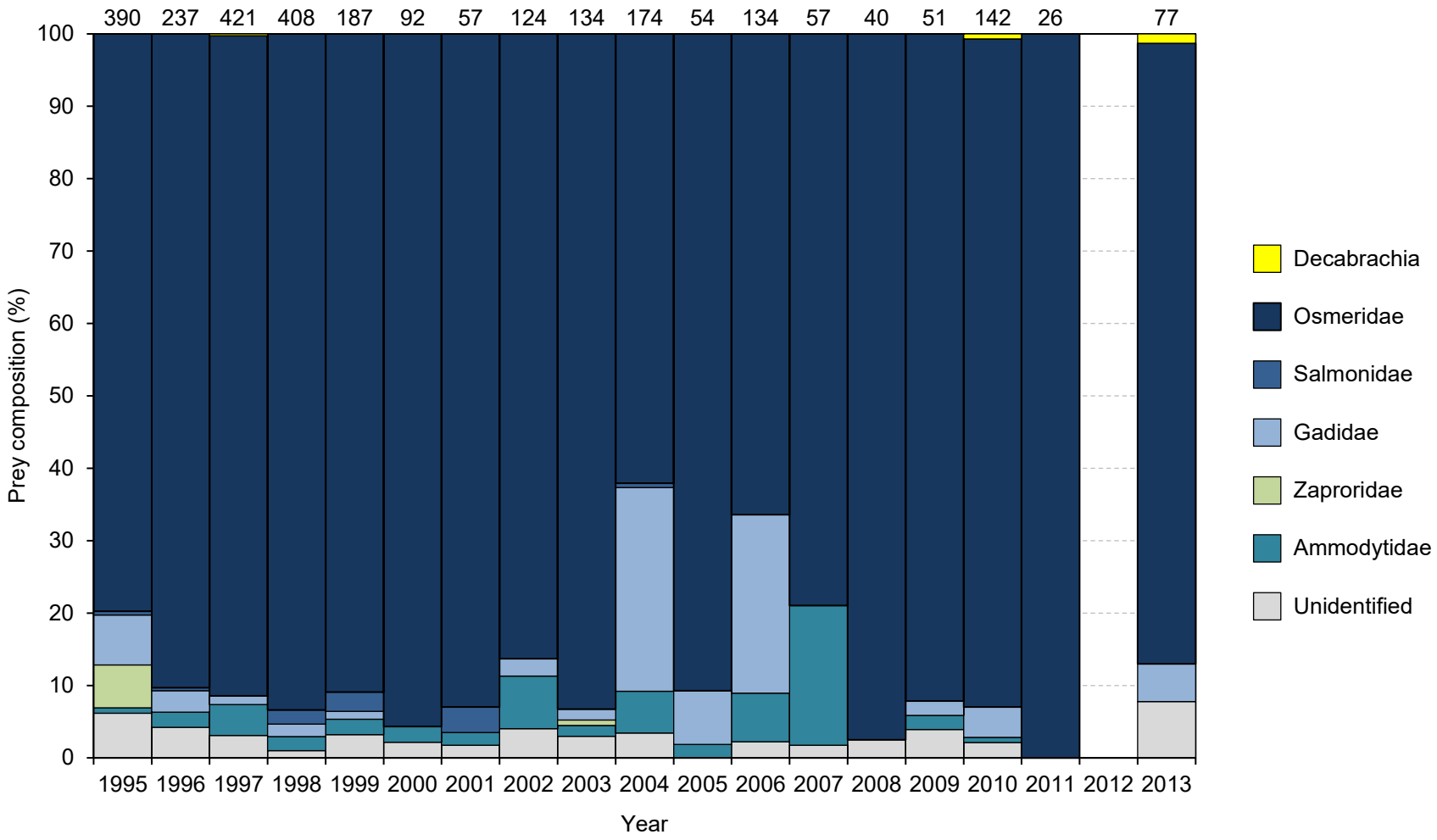

Figure 9. Prey composition (for each prey type, percentage of the total number of prey items) for observations of murre bill-loads at East Amatuli Island, Alaska. Sample sizes are above columns. Observations were not made in 2012 and after 2013.

Table 8. Prey composition (for each prey type, percentage of the total number of items of all prey types) for observations of murre bill-loads at East Amatuli Island, Alaska. (Continued on next page.)

Prey	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
No. samples	390	237	421	408	187	92	57	124	134	174
Invertebrates	**-**	**-**	**0.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Cephalopoda	**-**	**-**	**0.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Decabrachia	**-**	**-**	**0.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. squid	-	-	0.2	-	-	-	-	-	-	-
Fish	**93.8**	**95.8**	**96.7**	**99.0**	**96.8**	**97.8**	**98.2**	**96.0**	**97.0**	**96.6**
Osmeridae	**79.7**	**90.3**	**91.2**	**93.4**	**90.9**	**95.7**	**93.0**	**86.3**	**93.3**	**62.1**
Mallotus villosus	79.7	90.3	91.2	93.4	90.9	95.7	93.0	86.3	93.3	62.1
Salmonidae	**0.5**	**0.4**	**-**	**2.0**	**2.7**	**-**	**3.5**	**-**	**-**	**0.6**
Unid. salmonid	0.5	0.4	-	2.0	2.7	-	3.5	-	-	0.6
Gadidae	**6.9**	**3.0**	**1.2**	**1.7**	**1.1**	**-**	**-**	**2.4**	**1.5**	**28.2**
Unid. gadid	6.9	3.0	1.2	1.7	1.1	-	-	2.4	1.5	28.2
Zaproridae	**5.9**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.7**	**-**
Zaprora silenus	5.9	-	-	-	-	-	-	-	0.7	-
Ammodytidae	**0.8**	**2.1**	**4.3**	**2.0**	**2.1**	**2.2**	**1.8**	**7.3**	**1.5**	**5.7**
Ammodytes personatus	0.8	2.1	4.3	2.0	2.1	2.2	1.8	7.3	1.5	5.7
Unidentified	**6.2**	**4.2**	**3.1**	**1.0**	**3.2**	**2.2**	**1.8**	**4.0**	**3.0**	**3.4**

Table 8 (continued with additional years). Prey composition (for each prey type, percentage of the total number of items of all prey types) for observations of murre bill-loads at East Amatuli Island, Alaska.

Prey	2005	2006	2007	2008	2009	2010	2011	2012	2013
No. samples	54	134	57	40	51	142	26	0	77
Invertebrates	**-**	**-**	**-**	**-**	**-**	**0.7**	**-**	**-**	**1.3**
Cephalopoda	**-**	**-**	**-**	**-**	**-**	**0.7**	**-**	**-**	**1.3**
Decabrachia	**-**	**-**	**-**	**-**	**-**	**0.7**	**-**	**-**	**1.3**
Unid. squid	-	-	-	-	-	0.7	-	-	1.3
Fish	**10-**	**97.8**	**98.2**	**97.5**	**96.1**	**97.2**	**10-**	**-**	**90.9**
Osmeridae	**90.7**	**66.4**	**78.9**	**97.5**	**92.2**	**92.3**	**10-**	**-**	**85.7**
Mallotus villosus	90.7	66.4	78.9	97.5	92.2	92.3	10-	-	85.7
Salmonidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. salmonid	-	-	-	-	-	-	-	-	-
Gadidae	**7.4**	**24.6**	**-**	**-**	**2.0**	**4.2**	**-**	**-**	**5.2**
Unid. gadid	7.4	24.6	-	-	2.0	4.2	-	-	5.2
Zaproridae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Zaprora silenus	-	-	-	-	-	-	-	-	-
Ammodytidae	**1.9**	**6.7**	**19.3**	**-**	**2.0**	**0.7**	**-**	**-**	**-**
Ammodytes personatus	1.9	6.7	19.3	-	2.0	0.7	-	-	-
Unidentified	**-**	**2.2**	**1.8**	**2.5**	**3.9**	**2.1**	**-**	**-**	**7.8**

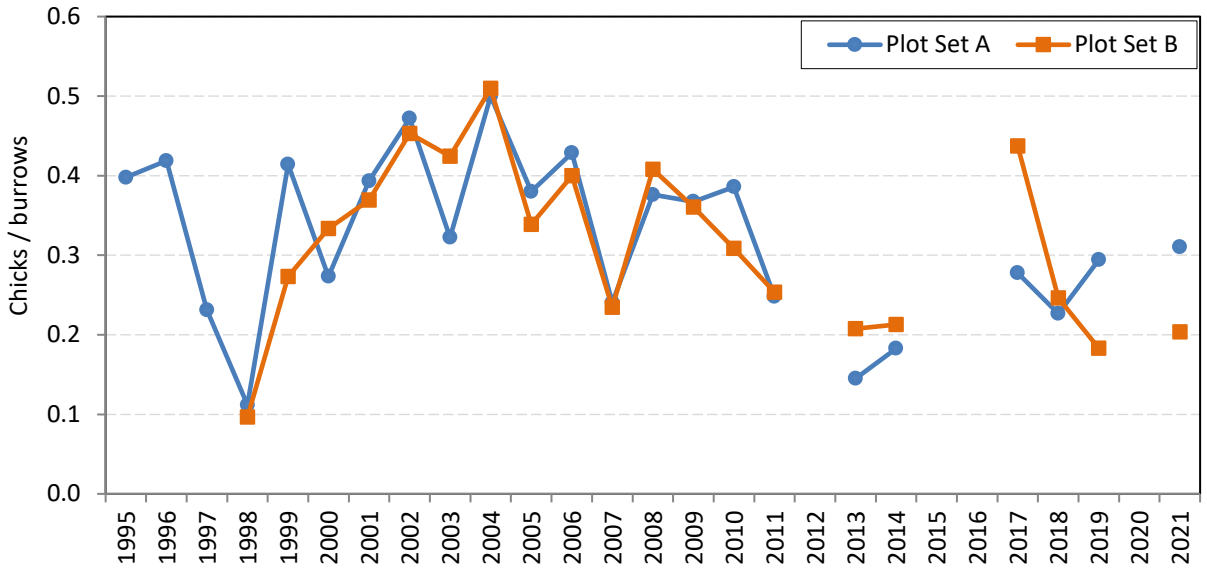

Figure 10. The proportion of tufted burrows counted that contained chicks in plots at East Amatuli Island, Alaska. Each point is the number of chicks summed across plots divided by the summed number of burrows. Plot Set A is comprised of plots AC, BC, C, and FWST; Plot Set B is comprised of plots OC, GC, SF, and EF. The two sets are plotted separately because of their different start years.

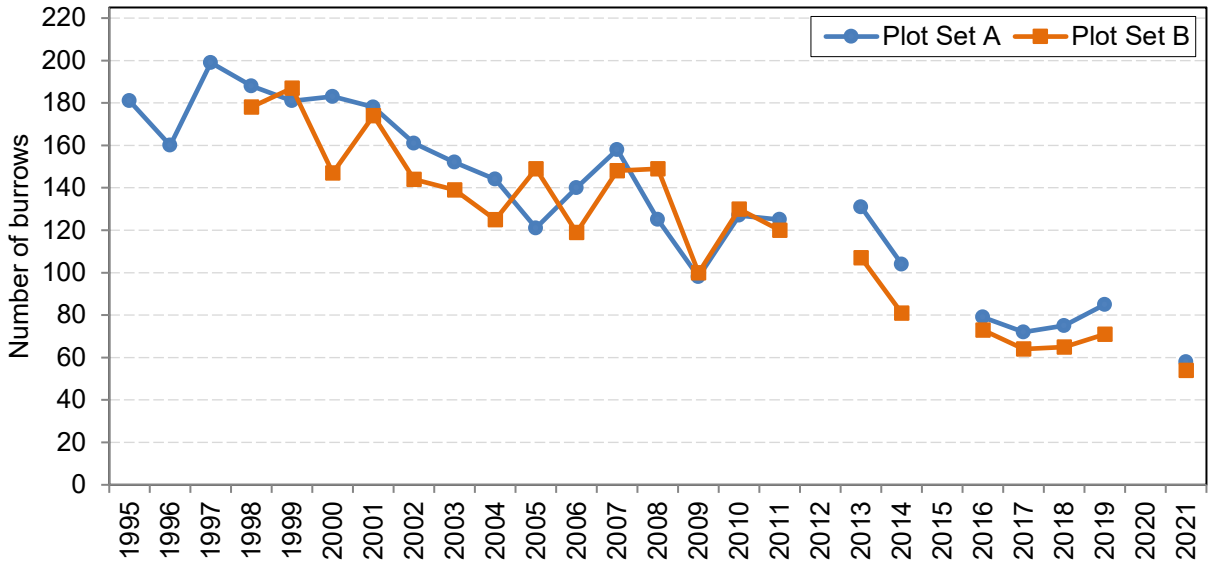

Figure 11. Number of tufted puffin burrows counted in plots at East Amatuli Island, Alaska. Plot Set A is comprised of plots AC, BC, C, and FWST; Plot Set B is comprised of plots OC, GC, SF, and EF. The rest of the colony may not reflect this pattern; the decline is at least partly caused by the monitoring activities themselves--see Kettle (2021a).

Table 9. Summary results from tufted puffin burrow searches in plots AC, BC, C, and FWST at East Amatuli Island, Alaska. This plot group has the longest monitoring history at this location. Data were not collected in 2012, 2015, and 2020.

Year	All Burrows	Burrows used	Burrows not used	Chicks	Used/ all burrows	Not used/ used burrows	Chicks/ all burrows	Chicks/ burrows used
1995	181	135	46	72	0.75	0.34	0.40	0.53
1996	160	126	34	76	0.79	0.27	0.48	0.60
1997	199	127	72	46	0.64	0.57	0.23	0.36
1998	188	93	95	21	0.49	1.02	0.11	0.23
1999	181	130	51	75	0.72	0.39	0.41	0.58
2000	183	135	48	50	0.74	0.36	0.27	0.37
2001	178	122	56	70	0.69	0.46	0.39	0.57
2002	161	112	49	76	0.70	0.44	0.47	0.68
2003	152	87	49	49	0.57	0.56	0.32	0.56
2004	144	115	26	72	0.80	0.23	0.50	0.63
2005	121	75	31	46	0.62	0.41	0.38	0.61
2006	140	105	34	59	0.75	0.32	0.42	0.56
2007	158	66	75	38	0.42	1.14	0.24	0.58
2008	125	71	50	47	0.57	0.70	0.38	0.66
2009	98	42	55	36	0.43	1.31	0.37	0.86
2010	127	92	32	43	0.72	0.35	0.34	0.47
2011	125	85	40	39	0.68	0.47	0.31	0.46
2012	-	-	-	-	-	-	-	-
2013	131	81	50	19	0.62	0.62	0.15	0.23
2014	104	47	54	19	0.45	1.15	0.18	0.40
2015	-	-	-	-	-	-	-	-
2016	79	37	22	-[a]	0.47	0.59	-	-
2017	72	54	17	20	0.75	0.31	0.28	0.37
2018	75	44	31	17	0.59	0.70	0.23	0.39
2019	85	59	26	25	0.69	0.44	0.29	0.42
2020	-	-	-	-	-	-	-	-
2021	58	33	25	18	0.57	0.76	0.31	0.55

[a] In 2016 some chicks may have fledged before burrow surveys began, so we are not reporting chick counts for that year.

Table 10. Summary results from tufted puffin burrow searches in plots OC, GC, SF, and EF at East Amatuli Island, Alaska. Data were not collected in 2012, 2015, and 2020.

Year	All Burrows	Burrows used	Burrows not used	Chicks	Used/ all burrows	Not used/ used burrows	Chicks/ all burrows	Chicks/ burrows used
1995	-	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-	-
1997	-	-	-	-	-	-	-	-
1998	178	81	97	19	0.46	1.20	0.11	0.23
1999	187	111	76	49	0.59	0.68	0.26	0.44
2000	147	80	34	49	0.54	0.43	0.33	0.61
2001	174	70	47	61	0.40	0.67	0.35	0.87
2002	144	90	70	66	0.63	0.78	0.46	0.73
2003	139	75	55	58	0.54	0.73	0.42	0.77
2004	125	103	22	66	0.82	0.21	0.53	0.64
2005	149	86	46	49	0.58	0.53	0.33	0.57
2006	119	83	35	44	0.70	0.42	0.37	0.53
2007	148	47	84	31	0.32	1.79	0.21	0.66
2008	149	78	67	58	0.52	0.86	0.39	0.74
2009	100	39	49	34	0.39	1.26	0.34	0.87
2010	130	92	26	34	0.71	0.28	0.26	0.37
2011	120	67	47	30	0.56	0.70	0.25	0.45
2012	-	-	-	-	-	-	-	-
2013	107	75	32	19	0.70	0.43	0.18	0.25
2014	81	37	37	12	0.46	1.00	0.15	0.32
2015	-	-	-	-	-	-	-	-
2016	73	27	18	-[a]	0.37	0.67	-	-
2017	64	35	26	26	0.55	0.74	0.41	0.74
2018	65	31	33	16	0.48	1.06	0.25	0.52
2019	71	30	41	13	0.42	1.37	0.18	0.43
2020	-	-	-	-	-	-	-	-
2021	54	37	17	11	0.69	0.46	0.20	0.30

[a] In 2016 some chicks may have fledged before burrow surveys began, so we are not reporting chick counts for that year.

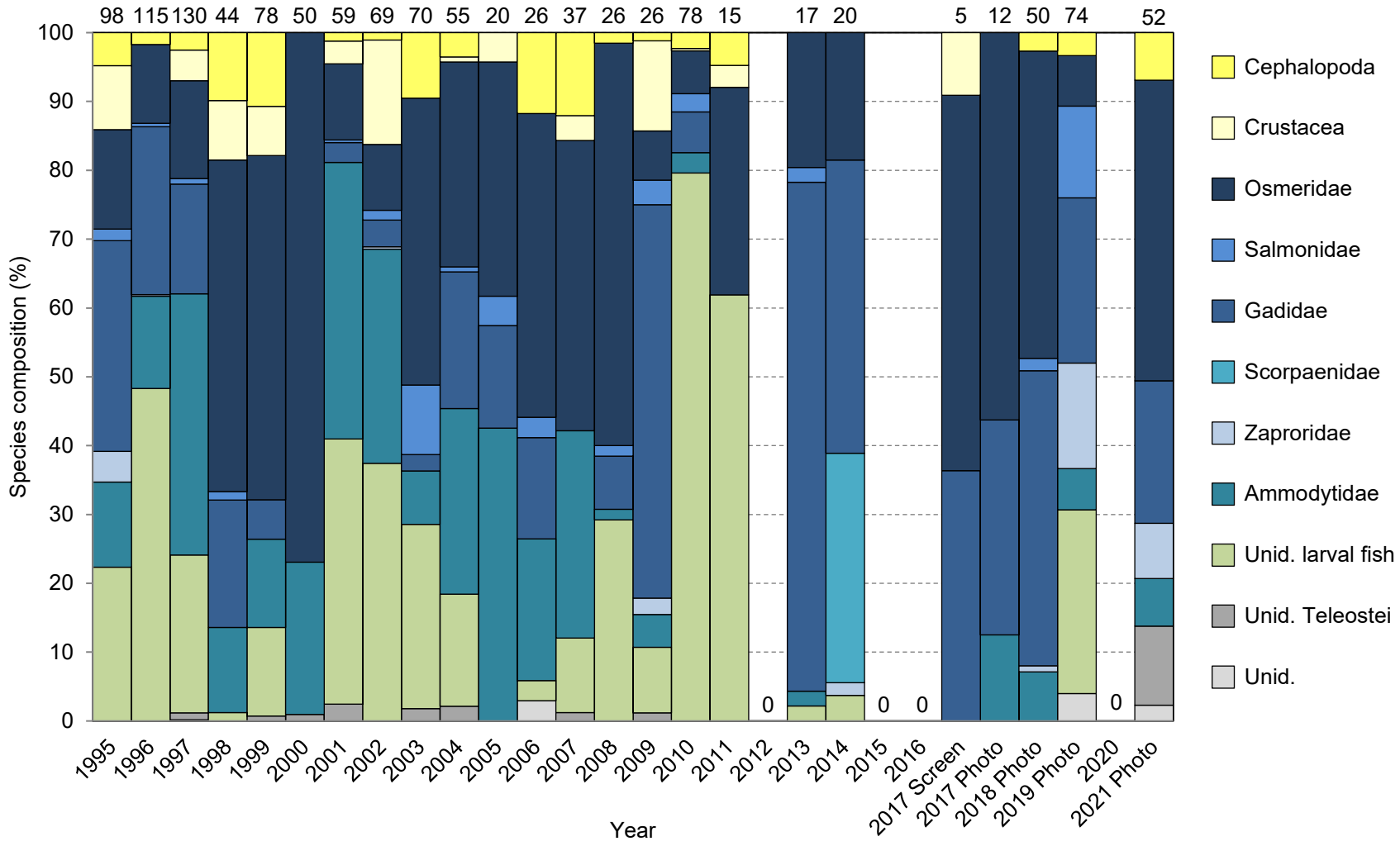

Figure 12. Prey composition (for each prey type, percentage of the total number of prey items of all types) in diets of tufted puffin chicks at East and West Amatuli islands, Alaska, Alaska. Samples were collected from burrow screening or found at burrows during chick growth and productivity monitoring, or (as labeled) were identified from photographs of flying adults. Sample sizes ("bill loads") are above columns. Prey categories with less than 5 percent composition in all years are omitted (except the "Unid." categories). Data were not collected in 2012, 2015, 2016, and 2020.

Table 11. Prey composition (for each prey type, percentage of the total number of prey items) in diets of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples ("bill-loads") were collected from burrow screening or found at burrows during chick growth and productivity monitoring, or (as labeled) were identified from photographs of flying adults.

Prey	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
No. samples	98	115	130	44	78	50	59	69	70	55	20	26	37	26	26
No. items	296	417	520	81	146	104	245	283	170	141	47	33	83	65	84
Invertebrates	**13.9**	**1.7**	**6.9**	**18.5**	**17.1**	**-**	**4.5**	**16.3**	**10.6**	**4.3**	**4.3**	**11.8**	**15.7**	**1.5**	**14.3**
Cephalopoda	**4.7**	**1.7**	**2.5**	**9.9**	**10.3**	**-**	**1.2**	**1.1**	**9.4**	**3.5**	**-**	**11.8**	**12.0**	**1.5**	**1.2**
Decabrachia	**4.7**	**1.4**	**2.3**	**8.6**	**8.9**	**-**	**1.2**	**1.1**	**8.8**	**3.5**	**-**	**11.8**	**2.4**	**1.5**	**1.2**
Unid. squid	4.7	1.4	2.3	8.6	8.9	-	1.2	1.1	8.8	3.5	-	11.8	2.4	1.5	1.2
Octopodidae	**-**	**0.2**	**0.2**	**1.2**	**0.7**	**-**	**-**	**-**	**0.6**	**-**	**-**	**-**	**9.6**	**-**	**-**
Unid. octopus	-	0.2	0.2	1.2	0.7	-	-	-	0.6	-	-	-	9.6	-	-
Unid. cephalopod	**-**	**-**	**-**	**-**	**0.7**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-
Crustacea	**9.1**	**-**	**4.4**	**8.6**	**6.8**	**-**	**3.3**	**15.2**	**-**	**0.7**	**4.3**	**-**	**3.6**	**-**	**13.1**
Euphausiaceae	**-**	**-**	**-**	**-**	**4.1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3.6**	**-**	**-**
Unid. euphausiid	-	-	-	-	4.1	-	-	-	-	-	-	-	3.6	-	-
Unid. crustacean	**9.1**	**-**	**4.4**	**8.6**	**2.7**	**-**	**3.3**	**15.2**	**-**	**0.7**	**4.3**	**-**	**-**	**-**	**13.1**
Unid. larval invertebrate	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.2**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. invertebrate	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Fish	**85.8**	**98.3**	**92.9**	**81.5**	**82.9**	**100.0**	**95.5**	**83.7**	**89.4**	**95.7**	**95.7**	**85.3**	**84.3**	**98.5**	**85.7**
Osmeridae	**14.2**	**11.3**	**14.0**	**48.1**	**47.9**	**76.9**	**11.0**	**9.5**	**41.2**	**29.8**	**34.0**	**44.1**	**42.2**	**58.5**	**7.1**
Hypomesus pretiosus	-	-	-	-	0.7	-	0.8	-	-	-	-	-	-	-	-
Mallotus villosus	14.2	11.3	14.0	48.1	47.3	76.9	10.2	9.5	41.2	29.8	34.0	44.1	42.2	58.5	7.1
Salmonidae	**1.7**	**0.5**	**0.8**	**1.2**	**-**	**-**	**0.4**	**1.4**	**10.0**	**0.7**	**4.3**	**2.9**	**-**	**1.5**	**3.6**
Oncorhynchus gorbuscha	1.7	0.5	0.8	1.2	-	-	0.4	1.4	10.0	0.7	4.3	2.9	-	1.5	3.6
Unid. salmonid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Myctophidae	**-**	**0.7**	**-**	**-**	**-**	**-**	**0.4**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. laternfish	-	0.7	-	-	-	-	0.4	-	-	-	-	-	-	-	-
Gadidae	**30.1**	**24.0**	**15.7**	**18.5**	**5.5**	**-**	**2.9**	**3.9**	**2.4**	**19.9**	**14.9**	**14.7**	**-**	**7.7**	**57.1**
Microgadus proximus	-	-	-	-	-	-	-	0.4	-	-	-	-	-	-	-
Gadus macrocephalus	4.1	0.5	0.2	2.5	-	-	-	0.4	-	-	-	2.9	-	-	1.2
Theragra chalcogramma	25.3	23.5	15.5	16.0	4.8	-	2.9	3.2	1.8	19.9	14.9	11.8	-	7.7	53.6
Unid. gadid	0.7	-	-	-	0.7	-	-	-	0.6	-	-	-	-	-	2.4
Scorpaenidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. *Sebastes* rockfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hexagrammidae	**-**	**-**	**-**	**-**	**0.7**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Ophiodon elongatus	-	-	-	-	0.7	-	-	-	-	-	-	-	-	-	-

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Table 11 (continued with additional rows). Prey composition (for each prey type, percentage of the total number of prey items) in diets of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples ("bill-loads") were collected from burrow screening or found at burrows during chick growth and productivity monitoring, or (as labeled) were identified from photographs of flying adults.

Prey	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cottidae	**0.3**	**0.2**	**-**	**-**	**0.7**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. sculpin	0.3	0.2	-	-	0.7	-	-	-	-	-	-	-	-	-	-
Cyclopteridae	**0.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Eumicrotremus orbis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unid. lumpsucker	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Liparidae	**0.7**	**-**	**-**	**-**	**0.7**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid snailfish	0.7	-	-	-	0.7	-	-	-	-	-	-	-	-	-	-
Zaproridae	**4.4**	**0.2**	**-**	**-**	**-**	**-**	**-**	**0.4**	**-**	**-**	**-**	**-**	**-**	**-**	**2.4**
Zaprora silenus	4.4	0.2	-	-	-	-	-	0.4	-	-	-	-	-	-	2.4
Ammodytidae	**12.2**	**13.2**	**37.4**	**12.3**	**12.3**	**22.1**	**40.0**	**31.1**	**7.6**	**27.0**	**42.6**	**20.6**	**30.1**	**1.5**	**4.8**
Ammodytes personatus	12.2	13.2	37.4	12.3	12.3	22.1	40.0	31.1	7.6	27.0	42.6	20.6	30.1	1.5	4.8
Pleuronectidae	**-**	**0.7**	**1.3**	**-**	**2.1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. flatfish	-	0.7	1.3	-	2.1	-	-	-	-	-	-	-	-	-	-
Unid. larval fish	**22.0**	**47.5**	**22.6**	**1.2**	**12.3**	**-**	**38.4**	**37.5**	**26.5**	**16.3**	**-**	**2.9**	**10.8**	**29.2**	**9.5**
Unid. fish	**-**	**-**	**1.0**	**-**	**0.7**	**1.0**	**2.4**	**-**	**1.8**	**2.1**	**-**	**-**	**1.2**	**-**	**1.2**
Unid. eggs	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid.	**-**	**-**	**0.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2.9**	**-**	**-**	**-**

Table 11 (continued with additional years). Prey composition (for each prey type, percentage of the total number of prey items) in diets of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples ("bill-loads") were collected from burrow screening or found at burrows during chick growth and productivity monitoring, or (as labeled) were identified from photographs of flying adults.

Prey	2010	2011	2012	2013	2014	2015	2016	2017 screen	2017 photo	2018 photo	2019 photo	2020	2021 photo
No. samples	78	15	0	17	20	0	0	5	12	50	74	0	51
No. items	306	64	-	46	54	-	-	11	32	112	144	-	85
Invertebrates	**2.6**	**7.8**	**-**	**-**	**-**	**-**	**-**	**9.1**	**-**	**2.7**	**3.3**	**-**	**7.1**
Cephalopoda	**2.3**	**4.7**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2.7**	**3.3**	**-**	**7.1**
Decabrachia	**2.0**	**4.7**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2.7**	**3.3**	**-**	**7.1**
Unid. squid	2.0	4.7	-	-	-	-	-	-	-	2.7	3.3	-	7.1
Octopodidae	**0.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. octopus	0.3	-	-	-	-	-	-	-	-	-	-	-	-
Unid. cephalopod	-	-	-	-	-	-	-	-	-	-	-	-	-
Crustacea	**0.3**	**3.1**	**-**	**-**	**-**	**-**	**-**	**9.1**	**-**	**-**	**-**	**-**	**-**
Euphausiaceae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. euphausiid	-	-	-	-	-	-	-	-	-	-	-	-	-
Unid. crustacean	**0.3**	**3.1**	**-**	**-**	**-**	**-**	**-**	**9.1**	**-**	**-**	**-**	**-**	-
Unid. larval invertebrate	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-
Unid. invertebrate	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-
Fish	**97.4**	**92.2**	**-**	**100.0**	**100.0**	**-**	**-**	**90.9**	**100.0**	**97.3**	**92.7**	**-**	**92.9**
Osmeridae	**6.2**	**29.7**	**-**	**19.6**	**18.5**	**-**	**-**	**54.5**	**56.3**	**44.6**	**7.3**	**-**	**44.7**
Hypomesus pretiosus	-	-	-	-	-	-	-	-	-	-	-	-	-
Mallotus villosus	6.2	29.7	-	19.6	18.5	-	-	54.5	56.3	44.6	7.3	-	44.7
Salmonidae	**2.6**	**-**	**-**	**2.2**	**-**	**-**	**-**	**-**	**-**	**1.8**	**13.3**	**-**	**-**
Oncorhynchus gorbuscha	2.0	-	-	-	-	-	-	-	-	-	13.3	-	-
Unid. salmonid	0.7	-	-	2.2	-	-	-	-	-	1.8	-	-	-
Myctophidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. laternfish	-	-	-	-	-	-	-	-	-	-	-	-	-
Gadidae	**5.9**	**-**	**-**	**73.9**	**42.6**	**-**	**-**	**36.4**	**31.2**	**43.0**	**24.0**	**-**	**21.2**
Microgadus proximus	-	-	-	-	-	-	-	-	-	-	-	-	-
Gadus macrocephalus	-	-	-	-	1.9	-	-	-	-	-	-	-	-
Theragra chalcogramma	5.9	-	-	73.9	40.7	-	-	36.4	-	4.5	-	-	-
Unid. gadid	-	-	-	-	-	-	-	-	31.2	38.4	24.0	-	21.2
Scorpaenidae	**-**	**-**	**-**	**-**	**33.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. *Sebastes* rockfish	-	-	-	-	33.3	-	-	-	-	-	-	-	-
Hexagrammidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Ophiodon elongatus	-	-	-	-	-	-	-	-	-	-	-	-	-

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Table 11 (continued with additional rows). Prey composition (for each prey type, percentage of the total number of prey items) in diets of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples (“bill-loads”) were collected from burrow screening or found at burrows during chick growth and productivity monitoring, or (as labeled) were identified from photographs of flying adults.

Prey	2010	2011	2012	2013	2014	2015	2016	2017 screen	2017 photo	2018 photo	2019 photo	2020	2021 photo
Cottidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**		**-**
Unid. sculpin	-	-	-	-	-	-	-	-	-	-	-		-
Cyclopteridae	**-**	**1.6**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**		**-**
Eumicrotremus orbis	-	1.6	-	-	-	-	-	-	-	-	-		-
Unid. lumpsucker	-	-	-	-	-	-	-	-	-	-	-		-
Liparidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**		**-**
Unid snailfish	-	-	-	-	-	-	-	-	-	-	-		-
Zaproridae	**-**	**-**	**-**	**-**	**1.9**	**-**	**-**	**-**	**-**	**0.9**	**15.3**		**8.2**
Zaprora silenus	-	-	-	-	1.9	-	-	-	-	-	15.3		8.2
Ammodytidae	**2.9**	**-**	**-**	**2.2**	**-**	**-**	**-**	**-**	**12.5**	**7.1**	**6.0**		**7.1**
Ammodytes personatus	2.9	-	-	2.2	-	-	-	-	12.5	-	6.0		7.1
Pleuronectidae	**0.7**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**		**-**
Unid. flatfish	0.7	-	-	-	-	-	-	-	-	-	-		-
Unid. larval fish	**79.1**	**60.9**	**-**	**2.2**	**3.7**	**-**	**-**	**-**	**-**	**-**	**26.7**		-
Unid. fish	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**		**11.8**
Unid. eggs	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**		-
Unid.	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**4.0**		**2.4**

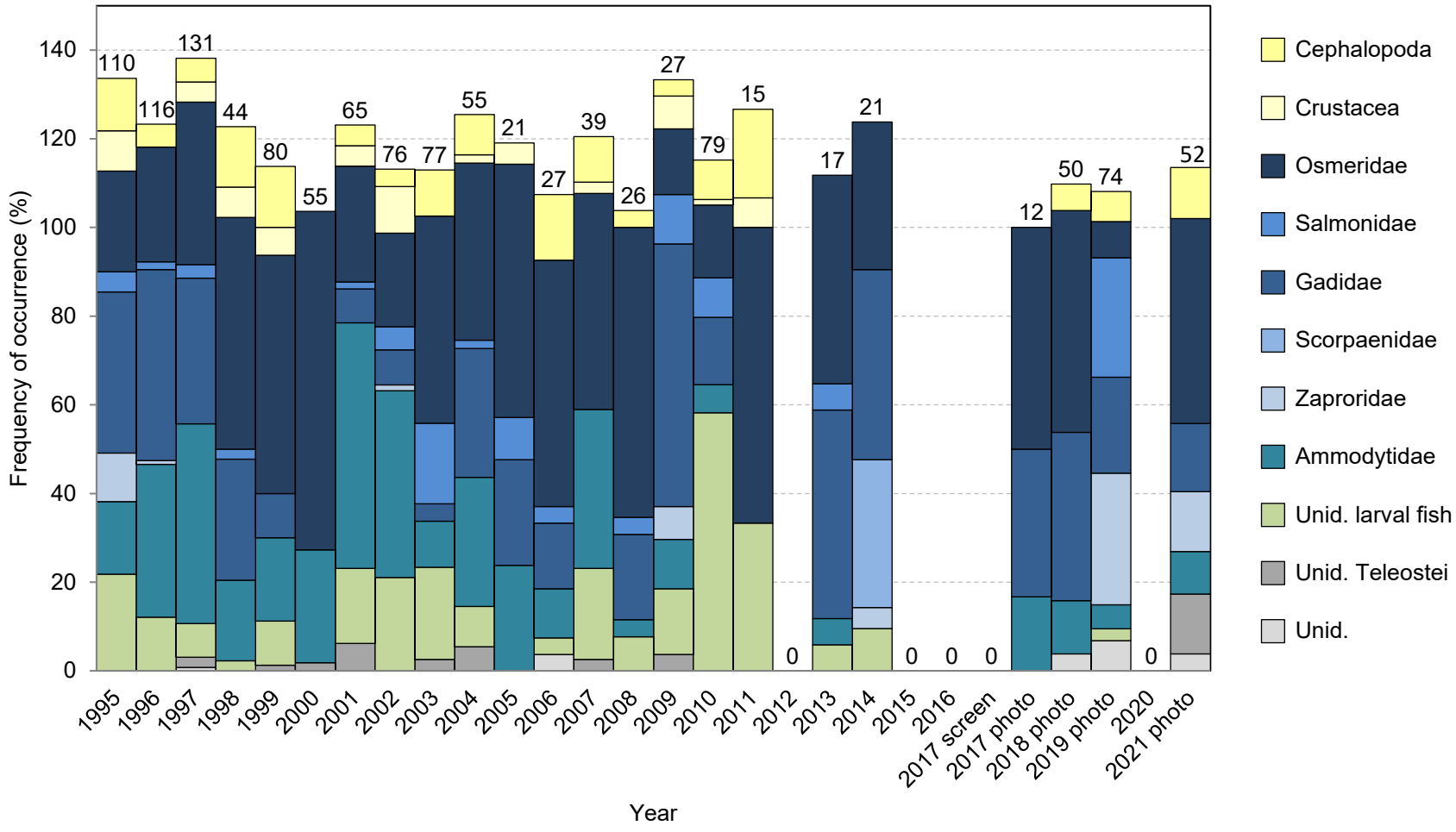

Figure 13. Frequency of occurrence of prey types (percentage of samples containing each prey type) in the diet of tufted puffin chicks at East and West Amatuli islands, Alaska. Sample sizes are above columns. Samples were collected from burrow screening or found at burrows during chick growth and productivity monitoring, or (as labeled) were identified from photographs of flying adults. Prey categories with less than 10 percent frequency in all years are omitted (except the “Unid.” categories). Data were not collected in 2012, 2015, 2016, and 2020.

Table 12. Frequency of occurrence of prey types (percentage of samples containing each prey type) in the diet of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples ("bill loads") were collected from burrow screening or found at burrows during chick growth and productivity monitoring, or (as labeled) were identified from photographs of flying adults.

Prey	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
No. samples	110	116	131	44	80	55	65	76	77	55	21	27	39	26	27
Invertebrates	**17.3**	**5.2**	**9.2**	**18.2**	**17.5**	**-**	**9.2**	**14.5**	**11.7**	**10.9**	**4.8**	**14.8**	**10.3**	**3.8**	**3.7**
Cephalopoda	**11.8**	**5.2**	**5.3**	**13.6**	**13.8**	**-**	**4.6**	**4.0**	**10.4**	**9.1**	**-**	**14.8**	**10.3**	**3.9**	**-**
Decabrachia	**11.8**	**4.3**	**4.6**	**11.4**	**11.3**	**-**	**4.6**	**3.9**	**9.1**	**9.1**	**-**	**14.8**	**5.1**	**3.8**	**-**
Unid. squid	11.8	4.3	4.6	11.4	11.3	-	4.6	3.9	9.1	9.1	-	14.8	5.1	3.8	-
Octopodidae	**-**	**0.9**	**0.8**	**2.3**	**1.3**	**-**	**-**	**-**	**1.3**	**-**	**-**	**-**	**5.1**	**-**	**7.4**
Unid. octopus	-	0.9	0.8	2.3	1.3	-	-	-	1.3	-	-	-	5.1	-	-
Unid. cephalopod	**-**	**-**	**-**	**-**	**1.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Crustacea	**9.1**	**-**	**4.6**	**6.8**	**6.3**	**-**	**4.6**	**10.5**	**-**	**1.8**	**4.8**	**-**	**2.6**	**-**	**7.4**
Euphausiaceae	**-**	**-**	**-**	**-**	**2.5**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2.6**	**-**	**-**
Unid. euphausiid	-	-	-	-	2.5	-	-	-	-	-	-	-	2.6	-	-
Unid. crustacean	**9.1**	**-**	**4.6**	**6.8**	**5.0**	**-**	**4.6**	**10.5**	**-**	**1.8**	**4.8**	**-**	**-**	**-**	**7.4**
Unid. larval invertebrate	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.3**	**-**	**-**	**-**	**-**	**-**	**-**
Fish	**94.5**	**99.1**	**100.0**	**90.9**	**88.8**	**98.2**	**92.3**	**88.2**	**88.3**	**90.9**	**100.0**	**81.5**	**97.4**	**100.0**	**96.3**
Osmeridae	**22.7**	**25.9**	**36.6**	**52.3**	**53.8**	**76.4**	**26.2**	**21.1**	**46.8**	**40.0**	**57.1**	**55.6**	**48.7**	**65.4**	**14.8**
Hypomesus pretiosus	-	-	-	-	1.3	-	1.5	-	-	-	-	-	-	-	-
Mallotus villosus	22.7	25.9	36.6	52.3	52.5	76.4	24.6	21.1	46.8	40.0	57.1	55.6	48.7	65.4	14.8
Salmonidae	**4.5**	**1.7**	**3.1**	**2.3**	**-**	**-**	**1.5**	**5.3**	**18.2**	**1.8**	**9.5**	**3.7**	**-**	**3.8**	**11.1**
Oncorhynchus gorbuscha	4.5	1.7	3.1	2.3	-	-	1.5	5.3	18.2	1.8	9.5	3.7	-	3.8	11.1
Unid. salmonid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Myctophidae	**-**	**2.6**	**-**	**-**	**-**	**-**	**1.5**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. laternfish	-	2.6	-	-	-	-	1.5	-	-	-	-	-	-	-	-
Gadidae	**36.4**	**43.1**	**32.8**	**27.3**	**10.0**	**-**	**7.7**	**7.9**	**3.9**	**29.1**	**23.8**	**14.8**	**-**	**19.2**	**59.3**
Microgadus proximus	-	-	-	-	-	-	-	1.3	-	-	-	-	-	-	-
Gadus macrocephalus	7.3	0.9	0.8	4.5	-	-	-	1.3	-	-	-	3.7	-	-	3.7
Theragra chalcogramma	29.1	42.2	32.1	25.0	8.8	-	7.7	6.6	2.6	29.1	23.8	11.1	-	19.2	55.6
Unid. gadid	1.8	-	-	-	1.3	-	-	-	1.3	-	-	-	-	-	3.7
Scorpaenidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. *Sebastes* rockfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hexagrammidae	**-**	**-**	**-**	**-**	**1.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Ophiodon elongatus	-	-	-	-	1.3	-	-	-	-	-	-	-	-	-	-

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Table 12 (continued with additional rows). Frequency of occurrence of prey types (percentage of samples containing each prey type) in the diet of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples ("bill loads") were collected from burrow screening or found at burrows during chick growth and productivity monitoring, or (as labeled) were identified from photographs of flying adults.

Prey	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cottidae	**0.9**	**0.9**	**-**	**-**	**1.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. sculpin	0.9	0.9	-	-	1.3	-	-	-	-	-	-	-	-	-	-
Cyclopteridae	**0.9**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Eumicrotremus orbis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unid. lumpsucker	0.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Liparidae	**0.9**	**-**	**-**	**-**	**1.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid snailfish	0.9	-	-	-	1.3	-	-	-	-	-	-	-	-	-	-
Zaproridae	**10.9**	**0.9**	**-**	**-**	**-**	**-**	**-**	**1.3**	**-**	**-**	**-**	**-**	**-**	**-**	**7.4**
Zaprora silenus	10.9	0.9	-	-	-	-	-	1.3	-	-	-	-	-	-	7.4
Ammodytidae	**16.4**	**34.5**	**45.0**	**18.2**	**18.8**	**25.5**	**55.4**	**42.1**	**10.4**	**29.1**	**23.8**	**11.1**	**35.9**	**3.8**	**11.1**
Ammodytes personatus	16.4	34.5	45.0	18.2	18.8	25.5	55.4	42.1	10.4	29.1	23.8	11.1	35.9	3.8	11.1
Pleuronectidae	**-**	**1.7**	**3.1**	**-**	**1.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. flatfish	-	1.7	3.1	-	1.3	-	-	-	-	-	-	-	-	-	-
Unid. larval fish	**21.8**	**12.1**	**7.6**	**2.3**	**10.0**	**-**	**16.9**	**21.1**	**20.8**	**9.1**	**-**	**3.7**	**20.5**	**7.7**	**14.8**
Unid. fish	**-**	**-**	**2.3**	**-**	**1.3**	**1.8**	**6.2**	**-**	**2.6**	**5.5**	**-**	**-**	**2.6**	**-**	**3.7**
Unid. eggs	**-**	**-**	**0.8**	**-**	**-**	**-**	**1.5**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid.	**-**	**-**	**0.8**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3.7**	**-**	**-**	**-**

Table 12 (continued with additional years). Frequency of occurrence of prey types (percentage of samples containing each prey type) in the diet of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples ("bill loads") were collected from burrow screening or found at burrows during chick growth and productivity monitoring, or (as labeled) were identified from photographs of flying adults.

Prey	2010	2011	2012	2013	2014	2015	2016	2017 screen	2017 photo	2018 photo	2019 photo	2020	2021 photo
No. samples	79	15	0	17	21	0	0	5	12	50	74	0	52
Invertebrates	**7.6**	**20.0**	**-**	**-**	**-**	**-**	**-**	**20.0**	**-**	**6.0**	**6.8**	**-**	**11.5**
Cephalopoda	**1.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**6.0**	**6.8**	**-**	**11.5**
Decabrachia	**1.3**	**-**	**-**	**-**	**-**	-	-	-	-	6.0	6.8	-	11.5
Unid. squid	-	-	-	-	-	-	-	-	-	-	-	-	-
Octopodidae	**1.3**	**6.7**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. octopus	-	-	-	-	-	-	-	-	-	-	-	-	-
Unid. cephalopod	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Crustacea	**1.3**	**6.7**	**-**	**-**	**-**	**-**	**-**	**20.0**	**-**	**-**	**-**	**-**	**-**
Euphausiaceae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. euphausiid	-	-	-	-	-	-	-	-	-	-	-	-	-
Unid. crustacean	**1.3**	**6.7**	**-**	**-**	**-**	**-**	**-**	**20.0**	**-**	**-**	**-**	**-**	**-**
Unid. larval invertebrate	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Fish	**92.4**	**100.0**	**-**	**100.0**	**100.0**	**-**	**-**	**100.0**	**100.0**	**98.0**	**89.2**	**-**	**86.5**
Osmeridae	**16.5**	**66.7**	**-**	**47.1**	**33.3**	**-**	**-**	**60.0**	**50.0**	**50.0**	**8.1**	**-**	**46.2**
Hypomesus pretiosus	-	-	-	-	-	-	-	-	-	-	-	-	-
Mallotus villosus	16.5	66.7	-	47.1	33.3	-	-	60.0	50.0	50.0	8.1	-	46.2
Salmonidae	**6.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**27.0**	**-**	**-**
Oncorhynchus gorbuscha	6.3	-	-	-	-	-	-	-	-	-	27.0	-	-
Unid. salmonid	2.5	-	-	5.9	-	-	-	-	-	-	-	-	-
Myctophidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. laternfish	-	-	-	-	-	-	-	-	-	-	-	-	-
Gadidae	**15.2**	**-**	**-**	**47.1**	**42.9**	**-**	**-**	**40.0**	**33.3**	**38.0**	**21.6**	**-**	**15.4**
Microgadus proximus	-	-	-	-	-	-	-	-	-	-	-	-	-
Gadus macrocephalus	-	-	-	-	4.8	-	-	-	-	-	-	-	-
Theragra chalcogramma	15.2	-	-	47.1	38.1	-	-	40.0	-	4.0	-	-	-
Unid. gadid	-	-	-	-	-	-	-	-	33.3	36.0	21.6	-	15.4
Scorpaenidae	**-**	**-**	**-**	**-**	**33.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. *Sebastes* rockfish	-	-	-	-	33.3	-	-	-	-	-	-	-	-
Hexagrammidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Ophiodon elongatus	-	-	-	-	-	-	-	-	-	-	-	-	-

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Table 12 (continued with additional rows). Frequency of occurrence of prey types (percentage of samples containing each prey type) in the diet of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples ("bill loads") were collected from burrow screening or found at burrows during chick growth and productivity monitoring, or (as labeled) were identified from photographs of flying adults.

Prey	2010	2011	2012	2013	2014	2015	2016	2017 screen	2017 photo	2018 photo	2019 photo	2020	2021 photo
Cottidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. sculpin	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyclopteridae	**-**	**6.7**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Eumicrotremus orbis	-	6.7	-	-	-	-	-	-	-	-	-	-	-
Unid. lumpsucker	-	-	-	-	-	-	-	-	-	-	-	-	-
Liparidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid snailfish	-	-	-	-	-	-	-	-	-	-	-	-	-
Zaproridae	**-**	**-**	**-**	**-**	**4.8**	**-**	**-**	**-**	**-**	**2.0**	**29.7**	**-**	**13.5**
Zaprora silenus	-	-	-	-	4.8	-	-	-	-	2.0	29.7	-	13.5
Ammodytidae	**6.3**	**-**	**-**	**5.9**	**-**	**-**	**-**	**-**	**16.67**	**12.0**	**5.4**	**-**	**9.6**
Ammodytes personatus	6.3	-	-	5.9	-	-	-	-	16.67	12.0	5.4	-	9.6
Pleuronectidae	**2.5**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. flatfish	2.5	-	-	-	-	-	-	-	-	-	-	-	-
Unid. larval fish	**58.2**	**33.3**	**-**	**5.9**	**9.5**	**-**	**-**	**-**	**-**	**-**	**2.7**	**-**	**-**
Unid. fish	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**13.5**
Unid. eggs	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid.	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**6.8**	**-**	**3.8**

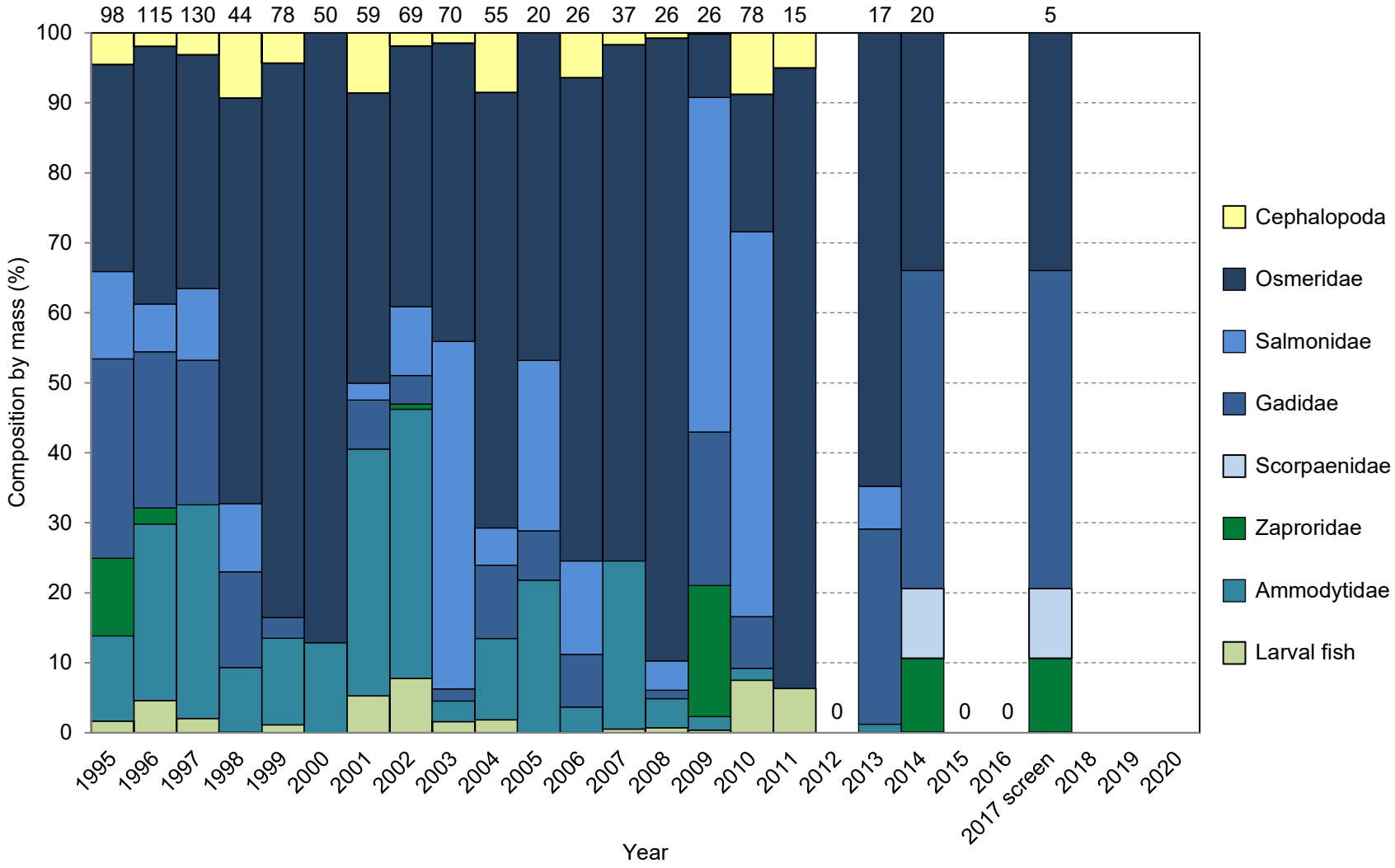

Figure 14. Biomass of prey types (for each prey type, percent of total sample mass) in the diet of tufted puffin chicks at East and West Amatuli islands, Alaska. Sample sizes are above columns. Prey categories with less than 5 percent mass in all years are omitted. Data were not collected in 2012, 2015, 2016, and 2020. Biomass estimation from photographs from 2017-2021 is not complete.

Table 13. Biomass of prey types (for each prey type, percent of mass of all samples) in the diet of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples ("bill-loads") were collected from burrow screening or found at burrows during chick growth and productivity monitoring. Biomass estimation from photographs in 2017-2021 is not yet complete.

Prey	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
No. samples	98	115	130	44	78	50	59	69	70	55	20	26	37	26
Total mass (g)	940.4	794.8	950.7	376.9	604.0	547.0	296.9	495.2	775.3	427.8	202.1	232.6	265.5	343.9
Invertebrates	**4.7**	**1.9**	**3.5**	**9.5**	**4.5**	**-**	**8.7**	**2.6**	**1.5**	**8.4**	**0.2**	**6.4**	**1.9**	**0.8**
Cephalopoda	**4.5**	**1.9**	**3.1**	**9.2**	**4.2**	**-**	**8.4**	**1.9**	**1.4**	**8.3**	**-**	**6.4**	**1.7**	**0.8**
Decabrachia	4.5	1.8	3.0	8.9	3.1	-	8.4	1.9	1.4	8.3	-	6.4	0.4	0.8
Unid. squid	4.5	1.8	3.0	8.9	3.1	-	8.4	1.9	1.4	8.3	-	6.4	0.4	0.8
Octopodidae	**-**	**0.1**	**0.1**	**0.3**	**1.1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.3**	**-**
Unid. octopus	-	0.1	0.1	0.3	1.1	-	-	-	-	-	-	-	1.3	-
Unid. cephalopod	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Crustacea	**0.2**	**-**	**0.4**	**0.3**	**0.3**	**-**	**0.3**	**0.7**	**-**	**0.1**	**0.2**	**-**	**0.2**	**-**
Euphausiaceae	**0.2**	**-**	**0.4**	**0.2**	**0.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.2**	**-**
Unid. euphausiid	0.2	-	0.4	0.2	0.3	-	-	-	-	-	-	-	0.2	-
Unid. crustacean	**-**	**-**	**-**	**0.1**	**-**	**-**	**0.3**	**0.7**	**-**	**0.1**	**0.2**	**-**	**-**	**-**
Unid. larval invertebrate	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.1**	**-**	**-**	**-**	**-**	**-**
Unid. invertebrate	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Fish	**95.3**	**98.2**	**96.2**	**90.3**	**94.4**	**100.0**	**91.3**	**97.5**	**98.4**	**91.7**	**99.8**	**93.5**	**98.0**	**99.2**
Osmeridae	**29.8**	**36.1**	**33.1**	**57.7**	**75.9**	**86.8**	**40.8**	**37.0**	**42.4**	**60.9**	**46.7**	**69.0**	**73.6**	**89.0**
Hypomesus pretiosus	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-
Mallotus villosus	29.8	36.1	33.1	57.7	75.9	86.8	40.3	37.0	42.4	60.9	46.7	69.0	73.6	89.0
Salmonidae	**12.3**	**6.7**	**10.1**	**9.7**	**-**	**-**	**2.4**	**9.8**	**49.3**	**5.2**	**24.3**	**13.3**	**-**	**4.2**
Oncorhynchus gorbuscha	12.3	6.7	10.1	9.7	-	-	2.4	9.8	49.3	5.2	24.3	13.3	-	4.2
Unid. salmonid	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Myctophidae	**-**	**0.6**	**-**	**-**	**-**	**-**	**0.1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. laternfish	**-**	**0.6**	**-**	**-**	**-**	**-**	**0.1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Gadidae	**28.0**	**21.9**	**20.4**	**13.6**	**2.8**	**-**	**6.9**	**4.1**	**1.8**	**10.3**	**7.0**	**7.5**	**-**	**1.2**
Microgadus proximus	-	-	-	-	-	-	-	1.0	-	-	-	-	-	-
Gadus macrocephalus	6.0	2.4	0.4	3.8	-	-	-	0.9	-	-	-	3.8	-	-
Theragra chalcogramma	20.6	19.5	20.0	9.8	2.6	-	6.9	2.2	1.4	10.3	7.0	3.7	-	1.2
Unid. gadid	1.4	-	-	-	0.2	-	-	-	0.4	-	-	-	-	-
Scorpaenidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. *Sebastes* rockfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hexagrammidae	**-**	**-**	**-**	**-**	**0.5**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Ophiodon elongatus	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-

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Table 13 (continued with additional rows). Biomass of prey types (for each prey type, percent of mass of all samples) in the diet of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples ("bill-loads") were collected from burrow screening or found at burrows during chick growth and productivity monitoring. Biomass estimation from photographs in 2017-2021 is not complete.

Prey	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Cottidae	**-**	**1.0**	**-**	**-**	**2.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. sculpin	-	1.0	-	-	2.2	-	-	-	-	-	-	-	-	-
Cyclopteridae	**0.1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Eumicrotremus orbis	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unid. lumpsucker	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-
Liparidae	**0.4**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid snailfish	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-
Zaproridae	**11.0**	**2.3**	**-**	**-**	**-**	**-**	**-**	**0.7**	**-**	**-**	**-**	**-**	**-**	**-**
Zaprora silenus	11.0	2.3	-	-	-	-	-	0.7	-	-	-	-	-	-
Ammodytidae	**12.0**	**24.9**	**30.2**	**9.2**	**11.9**	**12.8**	**34.7**	**38.2**	**2.9**	**11.4**	**21.8**	**3.6**	**23.9**	**4.1**
Ammodytes personatus	12.0	24.9	30.2	9.2	11.9	12.8	34.7	38.2	2.9	11.4	21.8	3.6	23.9	4.1
Pleuronectidae	**-**	**0.2**	**0.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. flatfish	-	0.2	0.3	-	-	-	-	-	-	-	-	-	-	-
Unid. larval fish	**1.7**	**4.5**	**2.0**	**0.1**	**1.1**	**-**	**5.2**	**7.7**	**1.6**	**1.8**	**-**	**0.1**	**0.5**	**0.7**
Unid. fish	**-**	**-**	**0.1**	**-**	**-**	**0.4**	**1.2**	**-**	**0.4**	**2.1**	**-**	**-**	**-**	**-**
Unid eggs	**-**	**-**	**0.1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Table 13 (continued with additional years). Biomass of prey types (for each prey type, percent of mass of all samples) in the diet of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples ("bill-loads") were collected from burrow screening or found at burrows during chick growth and productivity monitoring. Biomass estimation from photographs in 2017-2021 is not complete.

Prey	2009	2010	2011	2012	2013	2014	2015	2016	2017
No. samples	26	78	15	0	17	20	0	0	5
Total mass (g)	296.8	689.5	86.2	-	204.7	118.9	-	-	52.7
Invertebrates	**0.5**	**8.7**	**5.4**	**-**	**-**	**-**	**-**	**-**	**0.1**
Cephalopoda	**0.1**	**8.7**	**4.9**	**-**	**-**	**-**	**-**	**-**	**-**
Decabrachia	**0.1**	**8.5**	**4.9**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. squid	0.1	8.5	4.9	-	-	-	-	-	-
Octopodidae	**-**	**0.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. octopus	-	0.2	-	-	-	-	-	-	-
Unid. cephalopod	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Crustacea	**0.4**	**-**	**0.5**	**-**	**-**	**-**	**-**	**-**	**0.1**
Euphausiaceae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. euphausiid	-	-	-	-	-	-	-	-	-
Unid. crustacean	**0.4**	**-**	**0.5**	**-**	**-**	**-**	**-**	**-**	**0.1**
Unid. larval invertebrate	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. invertebrate	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Fish	**99.5**	**90.8**	**94.6**	**-**	**100.0**	**100.0**	**-**	**-**	**99.9**
Osmeridae	**9.0**	**19.5**	**87.0**	**-**	**64.8**	**34.0**	**-**	**-**	**78.0**
Hypomesus pretiosus	-	-	-	-	-	-	-	-	-
Mallotus villosus	9.0	19.5	87.0	-	64.8	34.0	-	-	78.0
Salmonidae	**47.6**	**54.6**	**-**	**-**	**6.1**	**-**	**-**	**-**	**-**
Oncorhynchus gorbuscha	47.6	45.1	-	-	-	-	-	-	-
Unid. salmonid	-	9.5	-	-	6.1	-	-	-	-
Myctophidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. laternfish	-	-	-	-	-	-	-	-	-
Gadidae	**21.9**	**7.4**	**-**	**-**	**27.9**	**45.4**	**-**	**-**	**21.9**
Microgadus proximus	-	-	-	-	-	-	-	-	-
Gadus macrocephalus	0.3	-	-	-	-	1.8	-	-	-
Theragra chalcogramma	20.3	7.4	-	-	27.9	43.6	-	-	21.9
Unid. gadid	1.3	-	-	-	-	-	-	-	-
Scorpaenidae	**-**	**-**	**-**	**-**	**-**	**10.0**	**-**	**-**	**-**
Unid. *Sebastes* rockfish	-	-	-	-	-	10.0	-	-	-
Hexagrammidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Ophiodon elongatus	-	-	-	-	-	-	-	-	-

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Table 13 (continued with additional rows). Biomass of prey types (for each prey type, percent of mass of all samples) in the diet of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples ("bill-loads") were collected from burrow screening or found at burrows during chick growth and productivity monitoring. Biomass estimation from photographs in 2017-2021 is not complete.

Prey	2009	2010	2011	2012	2013	2014	2015	2016	2017
Cottidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. sculpin	-	-	-	-	-	-	-	-	-
Cyclopteridae	**-**	**-**	**1.4**	**-**	**-**	**-**	**-**	**-**	**-**
Eumicrotremus orbis	-	-	1.4	-	-	-	-	-	-
Unid. lumpsucker	-	-	-	-	-	-	-	-	-
Liparidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid snailfish	-	-	-	-	-	-	-	-	-
Zaproridae	**18.7**	**-**	**-**	**-**	**-**	**10.5**	**-**	**-**	**-**
Zaprora silenus	18.7	-	-	-	-	10.5	-	-	-
Ammodytidae	**1.9**	**1.7**	**-**	**-**	**1.2**	**-**	**-**	**-**	**-**
Ammodytes personatus	1.9	1.7	-	-	1.2	-	-	-	-
Pleuronectidae	**-**	**0.1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. flatfish	-	0.1	-	-	-	-	-	-	-
Unid. larval fish	**0.4**	**7.5**	**6.2**	**-**	**0.1**	**0.1**	**-**	**-**	**-**
Unid. fish	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid eggs	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

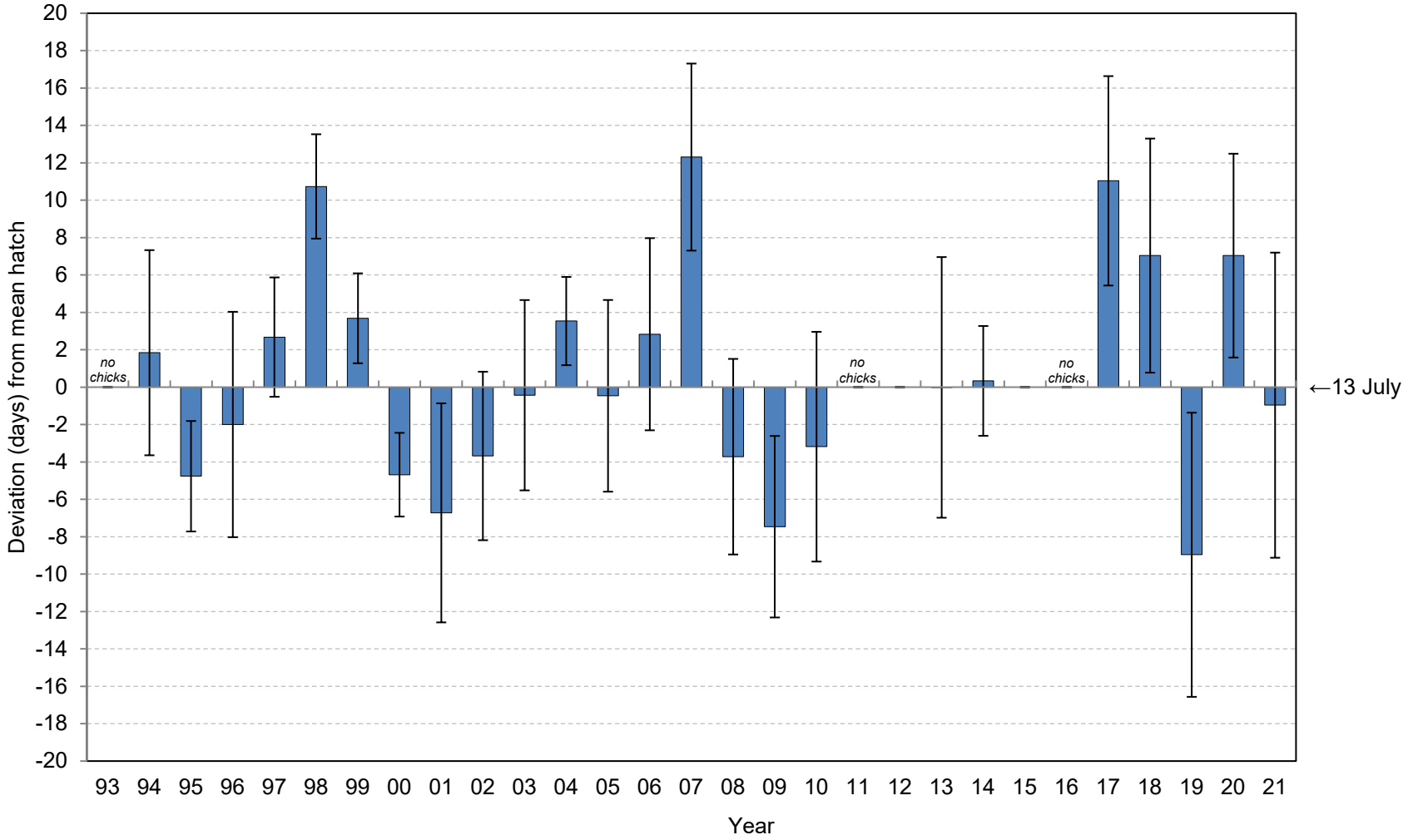

Figure 15. Yearly deviation from the mean (13 July) for hatch dates of black-legged kittiwakes at East Amatuli Island, Alaska. For the years before 2017, hatch dates were back-calculated from disappearance dates of chicks last observed after a "fledge start date" estimated for the combined plots each year (this date was estimated from the charted curve of that year's chick-departure dates). During 2017-2019, hatch dates were determined from analysis of time-lapse images. Error bars show one standard deviation from the mean for each year's dataset. No data were collected in 2012 and 2015.

Table 14. Mean hatch dates of black-legged kittiwakes in monitoring plots at East Amatuli Island, Alaska, calculated from (A) egg-to-chick observations and from (B) fledge dates. Within years, irregular observation intervals before 2014 cause artificial clumping of hatch date distribution; this affects dispersion values. Dashes indicate that data were insufficient for the calculation. In 2012 and 2015 egg and early chick data were not collected.

Year	(A) From egg-to-chick observations			(B) Back-calculation from fledge dates		
	Mean hatch	SD	*n*	Mean hatch	SD	n
1993	*no chicks*	-	-	-	-	-
1994	15 July	7.8	18	15 July	5.5	93
1995	7 July	4.2	205	9 July	3.0	235
1996	7 July	7.7	105	10 July	6.0	185
1997	17 July	4.5	127	16 July	3.2	81
1998	26 July	7.7	27	24 July	2.8	10
1999	19 July	3.3	164	17 July	2.4	51
2000	-	-	-	8 July	2.2	101
2001	-	-	-	7 July	5.9	202
2002	-	-	-	10 July	4.5	211
2003	-	-	-	13 July	5.1	211
2004	-	-	-	16 July	2.4	15
2005	-	-	-	13 July	5.1	8
2006	-	-	-	16 July	5.1	178
2007	-	-	-	26 July	5.0	13
2008	-	-	-	9 July	5.2	196
2009	-	-	-	6 July	4.9	8
2010	-	-	-	10 July	6.1	25
2011	*no chicks*	-	-	-	-	-
2012	-	-	-	-	-	-
2013	-	-	-	13 July	7.0	215
2014	19 July	3.2	15	14 July	2.9	10
2015	-	-	-	-	-	-
2016	*no chicks*	-	-	-	-	-
2017	25 July	5.6	19	17 July	3.7	9
2018	21 July	6.3	34	17 July	4.6	8
2019	-	-	-	5 July	8.0	76
2020	20 July	5.5	39	17 July	5.0	24
2021	13 July	8.2	64	12 July	8.7	53
Mean	17 July			13 July		

Table 15. Frequency distribution of hatch dates for black-legged kittiwakes at East Amatuli Island, Alaska. Columns labeled "(a)" contains hatch dates calculated from egg-to-chick observations. Column (a) contains hatch dates calculated from egg-to-chick observations. Column (b) lists hatch dates back-calculated from disappearance dates, for chicks that disappeared after the "fledge start date" estimated for each year. Irregular observation dates before 2014 cause artificial clumping of data distribution. Data were not collected in 2012 and 2015.

Date	Year													
	1993	1994 (a)	1994 (b)	1995 (a)	1995 (b)	1996 (a)	1996 (b)	1997 (a)	1997 (b)	1998 (a)	1998 (b)	1999 (a)	1999 (b)	2000 (b)
28 Jun	*no*	0	0	0	0	1	0	0	0	0	0	0	0	0
29 Jun	*chicks*	0	0	1	0	1	0	0	0	0	0	0	0	0
30 Jun	-	0	0	0	0	8	0	0	0	0	0	0	0	0
01 Jul	-	0	0	0	0	30	0	0	0	0	0	0	0	0
02 Jul	-	0	0	0	0	0	0	0	0	0	0	0	0	0
03 Jul	-	0	0	12	0	3	27	0	0	0	0	0	0	0
04 Jul	-	0	0	14	0	2	0	0	0	0	0	0	0	0
05 Jul	-	0	0	31	2	10	27	0	0	0	0	0	0	0
06 Jul	-	1	0	40	54	6	0	0	0	0	0	0	0	0
07 Jul	-	0	0	37	0	0	1	0	0	0	0	0	0	50
08 Jul	-	0	6	13	69	2	2	0	0	0	0	0	0	0
09 Jul	-	0	0	1	0	0	34	0	0	0	0	0	0	27
10 Jul	-	4	16	2	2	4	0	0	0	0	0	0	0	0
11 Jul	-	5	0	38	48	5	0	11	0	0	0	0	0	14
12 Jul	-	0	6	3	35	0	24	4	13	0	0	0	0	0
13 Jul	-	0	11	0	0	7	0	9	0	1	0	4	0	0
14 Jul	-	0	9	2	19	2	0	13	0	2	0	5	12	10
15 Jul	-	0	0	1	0	2	25	5	28	0	0	6	0	0
16 Jul	-	3	4	2	1	1	1	0	0	3	0	12	0	0
17 Jul	-	2	7	2	5	3	3	17	16	0	0	19	0	0
18 Jul	-	0	0	0	0	12	0	17	0	0	0	37	28	0
19 Jul	-	0	0	0	0	0	27	2	7	1	0	14	0	0
20 Jul	-	0	12	1	0	1	6	20	0	0	0	18	6	0
21 Jul	-	1	1	0	0	0	0	5	0	1	3	24	1	0
22 Jul	-	0	5	0	0	0	0	11	16	1	0	4	0	0
23 Jul	-	0	3	0	0	2	7	3	1	0	0	1	4	0
24 Jul	-	0	0	2	0	0	1	3	0	0	1	4	0	0
25 Jul	-	0	13	1	0	0	0	2	0	3	0	8	0	0
26 Jul	-	0	0	0	0	1	0	1	0	1	5	0	0	0
27 Jul	-	1	0	0	0	0	0	1	0	0	0	3	0	0
28 Jul	-	0	0	1	0	1	0	3	0	3	2	3	0	0
29 Jul	-	0	0	0	0	0	0	0	0	1	0	1	0	0
30 Jul	-	0	0	1	0	0	0	0	0	2	0	1	0	0
31 Jul	-	0	0	0	0	0	0	1	0	1	0	0	0	0
01 Aug	-	0	0	0	0	1	0	0	0	1	0	0	0	0
02 Aug	-	0	0	0	0	0	0	0	0	1	0	0	0	0
03 Aug	-	0	0	0	0	0	0	1	0	2	0	0	0	0
04 Aug	-	0	0	0	0	0	0	0	0	1	0	0	0	0
05 Aug	-	0	0	0	0	0	0	0	0	1	0	0	0	0
06 Aug	-	0	0	0	0	0	0	0	0	2	0	0	0	0
n	-	12	93	122	235	53	185	64	81	10	11	101	51	101

Table 15 (year-columns continued). Frequency distribution of hatch dates for black-legged kittiwakes at East Amatuli Island, Alaska. Columns labeled "(a)" contains hatch dates calculated from egg-to-chick observations. Column (a) contains hatch dates calculated from egg-to-chick observations. Column (b) lists hatch dates back-calculated from disappearance dates, for chicks that disappeared after the "fledge start date" estimated for each year. Irregular observation dates before 2014 cause artificial clumping of data distribution. Data were not collected in 2012 and 2015.

Date	Year														
	2001 (b)	2002 (b)	2003 (b)	2004 (b)	2005 (b)	2006 (b)	2007 (b)	2008 (b)	2009 (b)	2010 (b)	2011	2012	2013 (b)	2014 (b)	2015
28 Jun	0	0	0	0	0	0	0	0	0	0	*no*	-	0	0	-
29 Jun	0	0	0	0	0	0	0	0	0	0	*chicks*	-	0	0	-
30 Jun	2	0	0	0	0	0	0	0	0	0	-	-	0	0	-
01 Jul	44	1	0	0	0	0	0	0	0	0	-	-	0	0	-
02 Jul	2	1	0	0	0	0	0	0	0	0	-	-	0	0	-
03 Jul	29	2	0	0	0	0	0	55	3	0	-	-	0	0	-
04 Jul	0	0	0	0	0	0	0	0	0	0	-	-	0	0	-
05 Jul	35	56	0	0	0	0	0	1	2	0	-	-	4	0	-
06 Jul	0	0	0	0	0	0	0	2	0	9	-	-	6	0	-
07 Jul	0	0	0	0	0	0	0	0	0	3	-	-	40	0	-
08 Jul	1	3	57	0	0	0	0	0	0	0	-	-	5	0	-
09 Jul	0	1	2	0	3	0	0	52	2	3	-	-	11	1	-
10 Jul	53	70	0	0	0	1	0	0	0	1	-	-	26	0	-
11 Jul	0	2	46	0	0	38	0	0	0	0	-	-	5	0	-
12 Jul	0	0	0	0	0	0	0	28	0	0	-	-	4	1	-
13 Jul	0	0	7	4	2	2	0	12	0	0	-	-	22	1	-
14 Jul	0	38	37	0	0	43	0	19	0	3	-	-	3	1	-
15 Jul	0	0	0	0	1	1	0	0	0	0	-	-	4	2	-
16 Jul	0	0	1	0	0	0	0	0	0	2	-	-	21	1	-
17 Jul	0	0	0	3	0	32	0	20	1	0	-	-	1	0	-
18 Jul	36	36	25	4	1	0	0	0	0	0	-	-	16	3	-
19 Jul	0	0	0	4	0	1	0	0	0	0	-	-	3	0	-
20 Jul	0	1	1	0	0	25	3	0	0	2	-	-	0	0	-
21 Jul	0	0	1	0	0	1	0	0	0	0	-	-	8	0	-
22 Jul	0	0	26	0	0	6	0	7	0	0	-	-	1	0	-
23 Jul	0	0	0	0	0	11	0	0	0	0	-	-	2	0	-
24 Jul	0	0	0	0	1	6	4	0	0	0	-	-	3	0	-
25 Jul	0	0	7	0	0	0	0	0	0	2	-	-	19	0	-
26 Jul	0	0	0	0	0	0	0	0	0	0	-	-	0	0	-
27 Jul	0	0	0	0	0	4	0	0	0	0	-	-	2	0	-
28 Jul	0	0	1	0	0	0	1	0	0	0	-	-	1	0	-
29 Jul	0	0	0	0	0	0	0	0	0	0	-	-	0	0	-
30 Jul	0	0	0	0	0	0	2	0	0	0	-	-	1	0	-
31 Jul	0	0	0	0	0	5	0	0	0	0	-	-	0	0	-
01 Aug	0	0	0	0	0	0	1	0	0	0	-	-	1	0	-
02 Aug	0	0	0	0	0	1	0	0	0	0	-	-	6	0	-
03 Aug	0	0	0	0	0	0	2	0	0	0	-	-	0	0	-
04 Aug	0	0	0	0	0	1	0	0	0	0	-	-	0	0	-
05 Aug	0	0	0	0	0	0	0	0	0	0	-	-	0	0	-
06 Aug	0	0	0	0	0	0	0	0	0	0	-	-	0	0	-
n	202	211	211	15	8	178	13	196	8	25	0	-	215	10	-

Table 15 (year-columns continued). Frequency distribution of hatch dates for black-legged kittiwakes at East Amatuli Island, Alaska. Columns labeled "(a)" contains hatch dates calculated from egg-to-chick observations. Column (a) contains hatch dates calculated from egg-to-chick observations. Column (b) lists hatch dates back-calculated from disappearance dates, for chicks that disappeared after the "fledge start date" estimated for each year. Irregular observation dates before 2014 cause artificial clumping of data distribution. Data were not collected in 2012 and 2015.

Date	Year					
	2016	2017 (a)	2018 (a)	2019 (b)	2020 (a)	2021 (a)
28 Jun	*no*	0	0	0	0	0
29 Jun	*chicks*	0	0	0	0	0
30 Jun	-	0	0	0	0	0
01 Jul	-	0	0	0	0	0
02 Jul	-	0	0	0	0	0
03 Jul	-	0	0	0	0	0
04 Jul	-	0	0	0	0	2
05 Jul	-	0	0	0	0	2
06 Jul	-	0	1	1	0	7
07 Jul	-	0	0	1	0	3
08 Jul	-	0	1	5	0	9
09 Jul	-	0	0	3	0	4
10 Jul	-	0	0	4	1	5
11 Jul	-	0	0	1	1	4
12 Jul	-	0	0	0	1	3
13 Jul	-	0	0	3	1	4
14 Jul	-	0	3	0	1	1
15 Jul	-	0	0	0	2	3
16 Jul	-	0	0	2	3	2
17 Jul	-	3	3	2	2	0
18 Jul	-	0	3	3	3	0
19 Jul	-	0	0	2	2	0
20 Jul	-	0	3	1	4	1
21 Jul	-	2	4	6	1	0
22 Jul	-	3	2	4	3	3
23 Jul	-	0	0	0	2	1
24 Jul	-	1	2	2	4	0
25 Jul	-	2	1	1	0	0
26 Jul	-	1	4	1	3	1
27 Jul	-	1	2	0	2	2
28 Jul	-	1	1	0	1	1
29 Jul	-	1	1	0	0	1
30 Jul	-	0	1	0	0	3
31 Jul	-	1	1	1	0	0
01 Aug	-	0	0	0	2	1
02 Aug	-	1	0	1	0	1
03 Aug	-	1	0	0	0	0
04 Aug	-	1	1	0	0	0
05 Aug	-	0	0	0	0	0
06 Aug	-	0	0	1	0	0
n	0	19	34	45	39	64

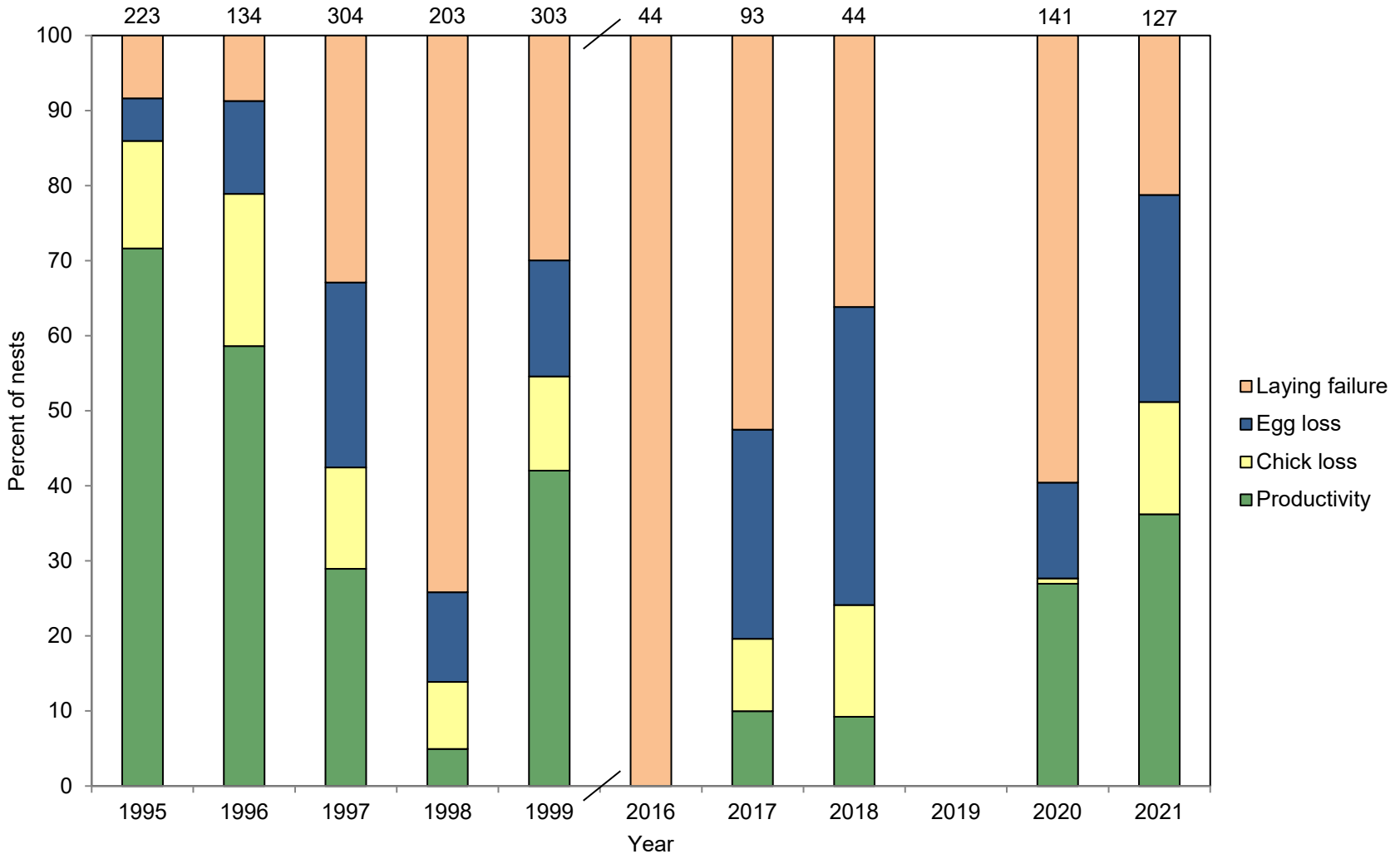

Figure 16. Reproductive performance of black-legged kittiwake nests in productivity plots at East Amatuli Island, Alaska. Laying failure = (A-B)/A, Egg loss = (B-D)/A), Chick loss = (D-F)/A, and Productivity = (F/A); where A = total nest sites, B = nest sites with eggs, D = nest sites with chicks, and F = nest sites with chicks fledged. Numbers above columns indicate sample sizes (A). Missing years had data inadequate for determining one or more of the components. In 2019 observations began after egg-laying had begun and some eggs may have already disappeared, so that year is not included.

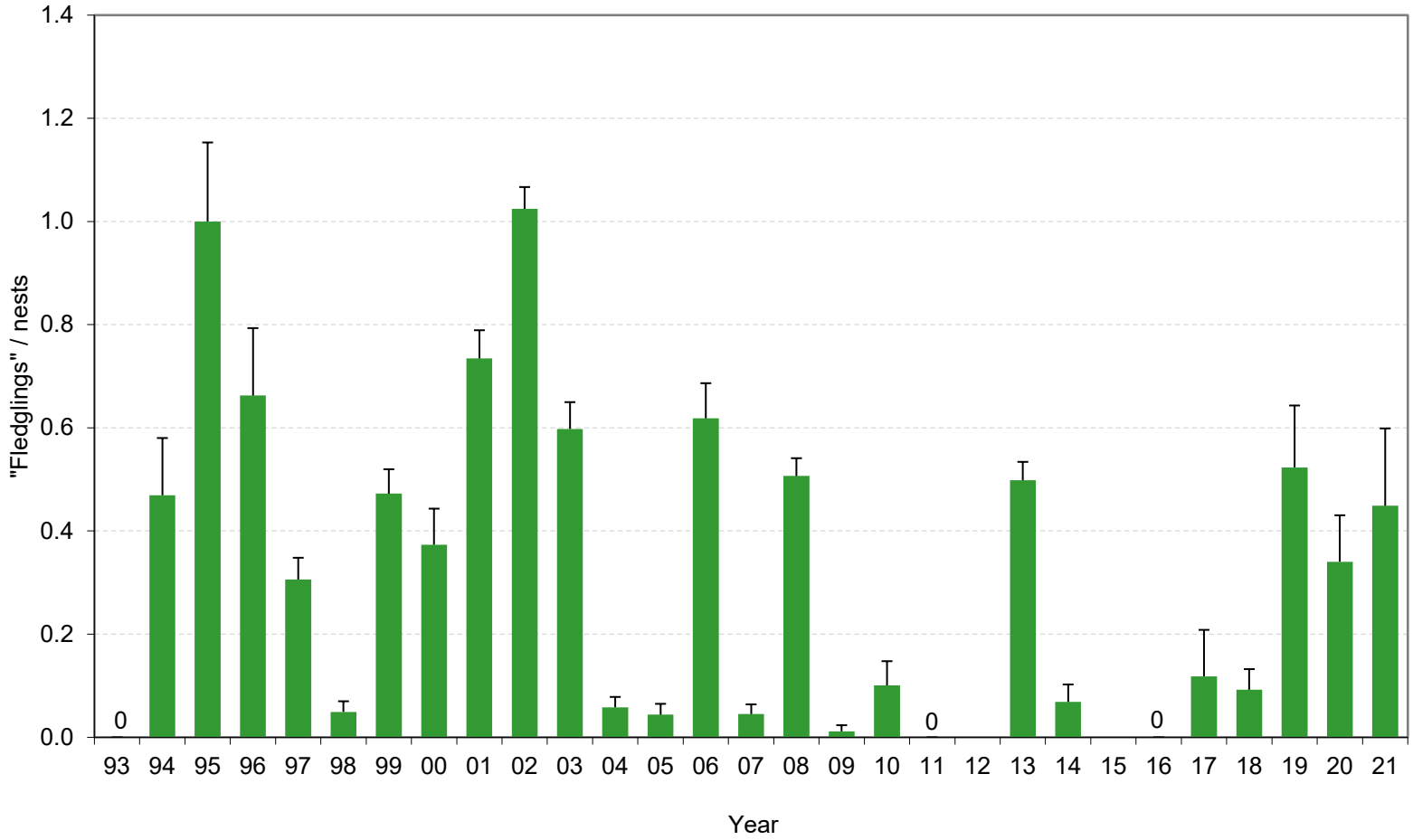

Figure 17. Fledglings/nests for black-legged kittiwakes in monitoring plots at East Amatuli Island, Alaska. For years with sufficient data (1993-1999 and 2016-2021), “fledglings” are those chicks that first leave the nest at age 32 days or older. For years when chick age could not be determined because observations began after chick-hatching had begun (2000-2014), we classified a chick as “fledged” if it (1) disappeared after its plumage indicated that it was ready to fledge, or (2) (during the years 2000-2003) was seen at the nest on or after the season’s estimated fledge-start date (estimated from the charted curve of that year’s chick-departure dates). Error bars show one standard deviation, calculated with a ratio estimator. No data were collected in 2012 or 2015. For more information (including a comparison of the proxy measurement), see Kettle (2016).

Table 16. Reproductive performance of black-legged kittiwakes on productivity plots at East Amatuli Island, Alaska. Observations covering most of the incubation period occurred only during 1994-1999 and in 2016-2019; parameters requiring egg data are dashed for the other years. 1977-1979 data are from Manuwal (1980). 1993-2014 data are from Kettle (2016). Data were not collected in 2012 and 2015.

Year	Number of plots	Total nest starts[a] (A')	Total adjusted nest starts (A)[b,c]	Nest sites with ≥ 1 egg (B)	Total eggs (C)	Nest sites with ≥ 1 chick[d] (D)	Adjusted nest sites with ≥ 1 chick (D')	Total chicks[d] (E)	Adjusted total chicks (E')	Nest sites with ≥ 1 chicks fledged (F)	Nest sites with ≥ 1 chicks "fledged"[e] (F')	Total chicks fledged (G)	Total chicks "fledged" (G')
1977	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	-	-	-	-	-	-	-	-	-	-	-	-	-
1979	-	-	-	-	-	-	-	-	-	-	-	-	-
'80-'92	*no data*	-	-	-	-	-	-	-	-	-	-	-	-
1993	5	161	-	0	0	0	0	0	0	0	0	0	0
1994	4	173	130.0 [c]	97	158	69	69	102	102	41	100	61	128
1995	11	370	223.0	339	607	318	192	512	320	160	277	223	383
1996	11	335	134.3	306	522	265	105	376	153	78	220	89	259
1997	11	304	304.0	204	285	129	129	168	168	88	108	93	122
1998	11	210	202.9	55	60	30	28	32	30	10	15	10	15
1999	11	311	302.8	218	294	170	165	211	205	127	128	143	144
2000	10	375	-	-	-	161	-	197	-	-	124	-	140
2001	11	448	-	-	-	251	-	330	-	-	251	-	329
2002	11	449	-	-	-	351	-	504	-	-	335	-	460
2003	11	470	-	-	-	264	-	345	-	-	235	-	281
2004	11	309	-	-	-	24	-	30	-	-	17	-	18
2005	11	274	-	-	-	11	-	12	-	-	11	-	12
2006	11	448	-	-	-	233	-	310	-	-	236	-	277
2007	11	467	-	-	-	25	-	26	-	-	19	-	21
2008	11	531	-	-	-	214	-	292	-	-	211	-	269
2009	10	345	-	-	-	17	-	17	-	-	4	-	4
2010	11	417	-	-	-	53	-	57	-	-	39	-	42
2011	11	258	-	-	-	0	-	0	-	-	0	-	0
2012	-	-	-	-	-	-	-	-	-	-	-	-	-
2013	11	556	-	-	-	245	-	304	-	-	228	-	277
2014	6	225	-	-	-	80	-	103	-	-	29	-	29
2015	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	4	44	44.0	0	0	0	0	0	0	0	0	0	0
2017	3	93	93.0	44	-	18	18	21	21	9	9	11	11
2018	5	141	141.0	90	109	34	34	36	36	13	13	13	13
2019	5	172	172.0	-	-	100	100	117	117	78	78	90	90
2020	5	141	141.0	57	-	39	39	55	55	38	38	48	48
2021	4	127	127.0	100	-	65	65	80	80	46	46	57	57

Table 16 (columns continued). Reproductive performance of black-legged kittiwakes on productivity plots at East Amatuli Island, Alaska. Observations covering most of the incubation period occurred only during 1994-1999 and in 2016-2019; parameters requiring egg data are dashed for the other years. 1977-1979 data are from Manuwal (1980). 1993-2014 data are from Kettle (2016). Data were not collected in 2012 and 2015.

Year	Laying success (B/A')	Laying failure (A'-B)/A'	Mean clutch size (C/B)	Nesting success (D/B)	Hatching success (E/C)	Egg loss (B-D)/A'	Chick success (G/E)	Chick loss (D'-F)/A	Egg success (G/C)	Fledging success (F/D)	Reprod. success (F/B)	Fledglings/ nest starts (G/A)	"Fledglings"/ nest starts[e] (G'/A')	Prod. (F/A)	"Prod."[f] (F'/A')
1977	-	-	-	-	-	-	-	-	-	-	-	0.90[g]	-	-	-
1978	-	-	-	-	-	-	-	-	-	-	-	0.15[g]	-	-	-
1979	-	-	-	-	-	-	-	-	-	-	-	0.14[g]	-	-	-
'80-'92	*no data*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1993	0.00	1.00	-	-	-	0.00	-	0.00	-	-	-	0.00	0.00	0.00	0.00
1994	0.56	0.44	1.63	0.71	0.65	0.16	0.60	0.22	0.39	0.59	1.65	0.47	*no data*	0.32	*no data*
1995	0.92	0.08	1.79	0.94	0.84	0.06	0.44	0.14	0.37	0.50	0.23	1.00	1.04	0.72	0.75
1996	0.91	0.09	1.71	0.87	0.72	0.12	0.24	0.20	0.17	0.29	0.29	0.66	0.77	0.58	0.66
1997	0.67	0.33	1.40	0.63	0.59	0.25	0.55	0.13	0.33	0.68	0.05	0.31	0.40	0.29	0.36
1998	0.26	0.74	1.09	0.55	0.53	0.12	0.31	0.09	0.17	0.33	2.31	0.05	0.07	0.05	0.07
1999	0.70	0.30	1.35	0.78	0.72	0.15	0.68	0.13	0.49	0.75	-	0.47	0.46	0.42	0.41
2000	-	-	-	-	-	-	-	-	-	-	-	-	0.37	-	0.33
2001	-	-	-	-	-	-	-	-	-	-	-	-	0.73	-	0.56
2002	-	-	-	-	-	-	-	-	-	-	-	-	1.02	-	0.75
2003	-	-	-	-	-	-	-	-	-	-	-	-	0.60	-	0.50
2004	-	-	-	-	-	-	-	-	-	-	-	-	0.06	-	0.06
2005	-	-	-	-	-	-	-	-	-	-	-	-	0.04	-	0.04
2006	-	-	-	-	-	-	-	-	-	-	-	-	0.62	-	0.53
2007	-	-	-	-	-	-	-	-	-	-	-	-	0.04	-	0.04
2008	-	-	-	-	-	-	-	-	-	-	-	-	0.51	-	0.40
2009	-	-	-	-	-	-	-	-	-	-	-	-	0.01	-	0.01
2010	-	-	-	-	-	-	-	-	-	-	-	-	0.10	-	0.09
2011	-	-	-	-	-	-	-	-	-	-	-	-	0.00	-	0.00
2012	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-	-	-	-	-	-	0.50	-	0.41
2014	-	-	-	-	-	-	-	-	-	-	-	-	0.13	-	0.13
2015	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2017	0.47	0.53	-	0.43	-	0.29	0.52	0.10	-	0.50	0.20	0.12	0.12	0.10	0.10
2018	0.64	0.36	1.21	0.38	-	0.40	0.36	0.15	-	0.38	0.14	0.09	0.09	0.09	0.09
2019	-	-	-	-	-	-	0.77	0.01	-	0.78	-	0.52	0.52	0.45	0.45
2020	0.40	0.60	-	0.68	-	-	0.87	0.07	-	0.97	0.67	0.34	0.34	0.27	0.27
2021	0.79	0.21	-	0.65	-	-	0.71	0.15	-	0.71	0.46	0.45	0.45	0.36	0.36

[a] Raw count of nest-starts (footnotes continue next page)

Table 16 (footnotes continued). Reproductive performance of black-legged kittiwakes on productivity plots at East Amatuli Island, Alaska. Observations covering most of the incubation period occurred only during 1994-1999 and in 2016-2019; parameters requiring egg data are dashed for the other years. 1977-1979 data are from Manuwal (1980). 1993-2014 data are from Kettle (2016). Data were not collected in 2012 and 2015.

[b] For years with observations during egg-hatching, "adjusted nests" are raw count of nests, minus nests with a large observation data gap around chick-hatching, minus a proportion of nests without chicks equal to the proportion of chick-nests that were dropped because of their hatch-date gap. It is this adjusted number of nests that is used as the divisor for ratios with numerators of: (1) chicks, (2) nests with chicks, (3) aged fledglings, or (4) nests with aged fledglings. Nests with large data gaps surrounding chick-hatching were dropped because (1) a chick could have been present and not seen before it died and (2) it couldn't be determined whether a chick that disappeared later fledged or did not, because the chick could not be aged with sufficient precision.

[c] In 1994 "Total adjusted nest starts" is the number of nest starts with definite content observation (whether empty or not). That year, poor boating conditions created data gaps and uncertain nest-content observations.

[d] During 1999-2013, observations began about halfway through the nestling period. Most eggs were not observed, and some chicks that died early may have been missed. For this reason, ratios that rely on the number of eggs or chicks produced have not been calculated.

[e] Chicks "fledged", and "fledglings" in quotes are based on chicks disappearing late in the season, rather than on ageing from hatch dates.

[f] "Prod." in quotes is Productivity (Nest sites with ≥ 1 chicks fledged) with chicks "fledged" based on chicks seen late in the season, rather than on chicks aged from hatch dates.

[g] 1977-1979 data are from Manuwal (1980).

Table 17. Standard deviation for reproductive performance parameters of black-legged kittiwakes on productivity plots at East Amatuli Island, Alaska. Values were calculated with ratio estimation. Sampling was clustered by plot. Pre-2015 data are from Kettle (2016). Data were not collected in 2012 and 2015.

Year	No. plots	Nest starts	Adjusted nest starts	Laying success	Mean clutch size	Nesting success	Hatching success	Chick success	Egg success	Fledging success	Reprod. success	Fledglings/ nest starts[a]	"Fledglings"/ nest starts	Prod.[a]	"Prod."
1993	5	161	161.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1994	4	173	130.0 [c]	0.08	0.03	0.08	0.08	0.01	0.06	0.03	0.07	0.11	0.08	0.18	0.33
1995	11	370	223.0	0.02	0.03	0.02	0.04	0.05	0.04	0.12	0.05	0.15	0.06	0.15	0.24
1996	11	335	134.3	0.02	0.05	0.04	0.03	0.03	0.02	0.16	0.04	0.13	0.06	0.18	0.21
1997	11	304	304.0	0.04	0.03	0.04	0.05	0.05	0.04	0.05	0.04	0.04	0.05	0.06	0.12
1998	11	210	202.9	0.04	0.04	0.10	0.09	0.12	0.07	0.13	0.08	0.02	0.03	0.03	0.02
1999	11	311	302.8	0.03	0.02	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.13
2000	10	375	-	-	-	-	-	-	-	-	-	-	0.07	-	0.11
2001	11	448	-	-	-	-	-	-	-	-	-	-	0.05	-	0.18
2002	11	449	-	-	-	-	-	-	-	-	-	-	0.04	-	0.25
2003	11	470	-	-	-	-	-	-	-	-	-	-	0.05	-	0.16
2004	11	309	-	-	-	-	-	-	-	-	-	-	0.02	-	0.02
2005	11	274	-	-	-	-	-	-	-	-	-	-	0.02	-	0.01
2006	11	448	-	-	-	-	-	-	-	-	-	-	0.07	-	0.18
2007	11	467	-	-	-	-	-	-	-	-	-	-	0.02	-	0.01
2008	11	531	-	-	-	-	-	-	-	-	-	-	0.03	-	0.13
2009	10	303	-	-	-	-	-	-	-	-	-	-	0.01	-	0.00
2010	11	384	-	-	-	-	-	-	-	-	-	-	0.05	-	0.03
2011	11	235	-	-	-	-	-	-	-	-	-	-	0.00	-	0.00
2012	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2013	11	556	-	-	-	-	-	-	-	-	-	-	0.04	-	0.13
2014	6	225	-	-	-	-	-	-	-	-	-	-	0.03	-	0.02
2015	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	4	44	44.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2017	3	93	93.0	0.01	-	0.20	-	0.12	-	0.13	0.16	0.09	0.09	0.07	0.07
2018	5	141	141.0	0.06	-	0.05	-	0.10	-	0.11	0.05	0.04	0.04	0.04	0.04
2019	5	172	172.0	-	-	-	-	0.07	-	0.08	-	0.12	0.12	0.09	0.09
2020	5	141	141.0	0.05	-	0.10	-	0.10	-	0.02	0.09	0.09	0.09	0.07	0.07
2021	4	127	127.0	0.00	-	0.15	-	0.06	-	0.07	0.15	0.15	0.15	0.12	0.12

[a] During 2000-2014 fledging was based on chicks seen late in the season, rather than on chicks aged from hatch dates.

Table 18. Reproductive performance of black-legged kittiwakes on productivity plots at East Amatuli Island, Alaska in 2021. Observations were made with time-lapse cameras.

Parameter	Plot[a]											Total[b]	SD[c]
	1	2	3	4	5	6	7	8	9	10	11		
Total nests (A)	35	-	-	23	-	40	-	-	-	-	29	127	-
Nests with ≥ 1 egg (B)	27	-	-	18	-	32	-	-	-	-	23	100	-
Total eggs (C)	-	-	-	-	-	-	-	-	-	-	-	-	-
Nests with ≥ chick (D)	7	-	-	11	-	28	-	-	-	-	19	65	-
Total chicks (E)	7	-	-	14	-	34	-	-	-	-	25	80	-
Nests with ≥ chick fledged (F)	2	-	-	9	-	22	-	-	-	-	13	46	-
Total chicks fledged (G)	2	-	-	12	-	26	-	-	-	-	17	57	-
Laying success (B/A)	0.77	-	-	0.78	-	0.8	-	-	-	-	0.8	0.8	-
Mean clutch size (C/B)	-	-	-	-	-	-	-	-	-	-	-	-	-
Nesting success (D/B)	0.26	-	-	0.61	-	0.88	-	-	-	-	0.83	0.65	-
Hatching success (E/C)	-	-	-	-	-	-	-	-	-	-	-	-	-
Chick success (G/E)	0.29	-	-	0.86	-	0.76	-	-	-	-	0.68	0.71	-
Egg success (G/C)	-	-	-	-	-	-	-	-	-	-	-	-	-
Fledging success (F/D)	0.29	-	-	0.82	-	0.79	-	-	-	-	0.68	0.71	-
Reproductive success (F/B)	-	-	-	-	-	-	-	-	-	-	-	-	-
Fledglings/nests (G/A)	0.06	-	-	0.52	-	0.65	-	-	-	-	0.59	0.45	-
Productivity (F/A)	0.06	-	-	0.39	-	0.55	-	-	-	-	0.45	0.36	-

[a] Productivity plots 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11 have respective field names K1-LC, K2-LC, K3-LC, K4-LC, K6-LC, K7-LC, K1-F, K2-F, K3-F, K4-F, and K5-F.

[b] Ratios in "Total" column were calculated from sums in this column.

[c] Standard deviation was calculated with a ratio estimator (see Methods in Kettle (2016).

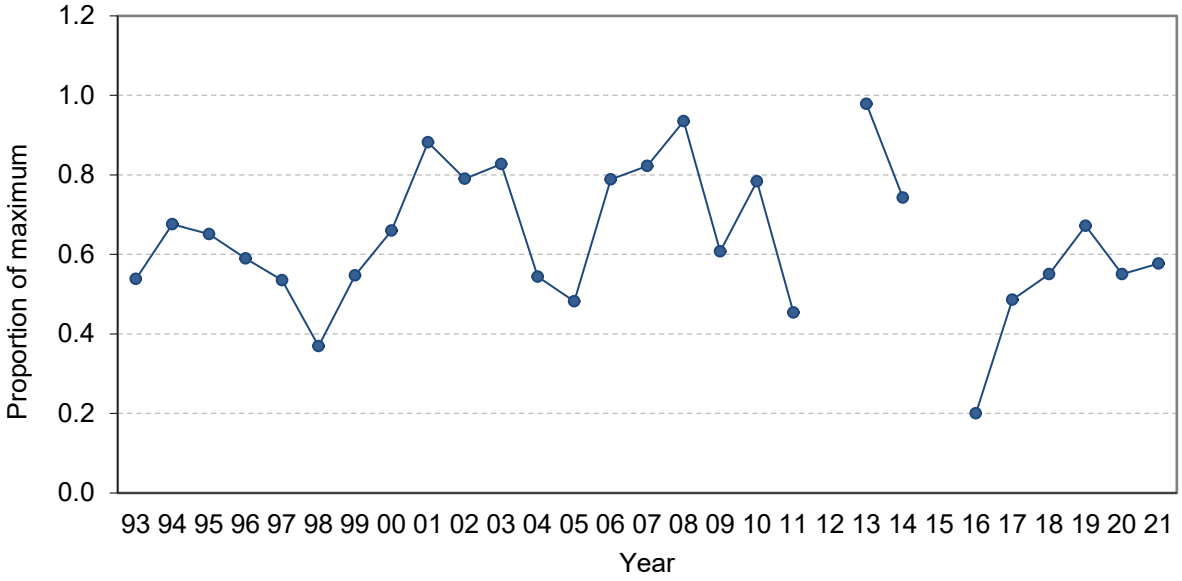

Figure 18. Number of black-legged kittiwake nests counted on productivity plots at East Amatuli Island, Alaska. To calculate the index for each year, counts that year were summed across plots; then this sum was divided by the sum of the among-year maximum counts for those plots. No data were collected in 2012 or 2015.

Table 19. Number of black-legged kittiwake nests counted on productivity plots at East Amatuli Island, Alaska. Pre-2015 data are from Kettle (2016). Data were not collected in 2012 and 2015.

Year	Plot[a]											Total	Proportion of maximum[b]
	1	2	3	4	5	6	7	8	9	10	11		
1993	34	41	33	-	-	-	28	25	-	-	-	161	0.54
1994	46	-	41	-	-	-	46	40	-	-	-	173	0.68
1995	46	26	35	29	36	35	49	29	33	29	23	370	0.65
1996	40	25	33	31	33	28	44	28	30	20	23	335	0.59
1997	34	22	35	27	26	32	36	34	24	11	23	304	0.54
1998	19	13	25	19	21	18	27	27	19	9	13	210	0.37
1999	31	20	34	28	34	32	37	30	26	20	19	311	0.55
2000	54	30	44	33	37	-	50	37	32	28	30	375	0.74
2001	54	40	58	34	32	48	55	41	31	25	30	448	0.79
2002	58	35	59	35	34	50	54	45	28	24	27	449	0.79
2003	59	35	68	31	39	49	53	44	32	31	29	470	0.83
2004	32	25	46	25	29	43	31	31	20	9	18	309	0.54
2005	21	4	50	15	23	27	35	33	22	26	18	274	0.48
2006	50	35	77	30	32	47	56	41	24	27	29	448	0.79
2007	54	26	76	32	38	46	55	39	37	34	30	467	0.82
2008	58	37	81	35	47	52	62	42	44	42	31	531	0.93
2009	37	22	67	-	42	35	39	27	25	28	23	345	0.65
2010	44	31	67	30	35	36	45	35	30	37	27	417	0.73
2011	30	19	35	20	37	27	32	23	12	12	11	258	0.45
2012	-	-	-	-	-	-	-	-	-	-	-	-	-
2013	56	43	90	36	48	60	57	42	43	42	39	556	0.98
2014	47	37	64	29	42	37	43	38	24	34	27	422	0.74
2015	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	27	-	-	-	-	11	2	-	-	-	4	44	0.20
2017	33	-	-	-	-	22	33	-	-	-	-	88	0.49
2018	34	-	-	25	-	23	38	-	-	-	21	141	0.55
2019	47	-	-	27	-	24	42	-	-	-	32	172	0.67
2020	40	-	-	20	-	23	36	-	-	-	22	141	0.55
2021	35	-	-	-	-	23	40	-	-	-	29	127	0.58
Max[c]	59	43	90	36	48	60	62	45	44	42	39	556	-

[a] Productivity plots 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11 have respective field names K1-LC, K2-LC, K3-LC, K4-LC, K6-LC, K7-LC, K1-F, K2-F, K3-F, K4-F, and K5-F.
[b] Percent of sum of among-year maximum counts for the plots counted each year.
[c] Among-year maximum count

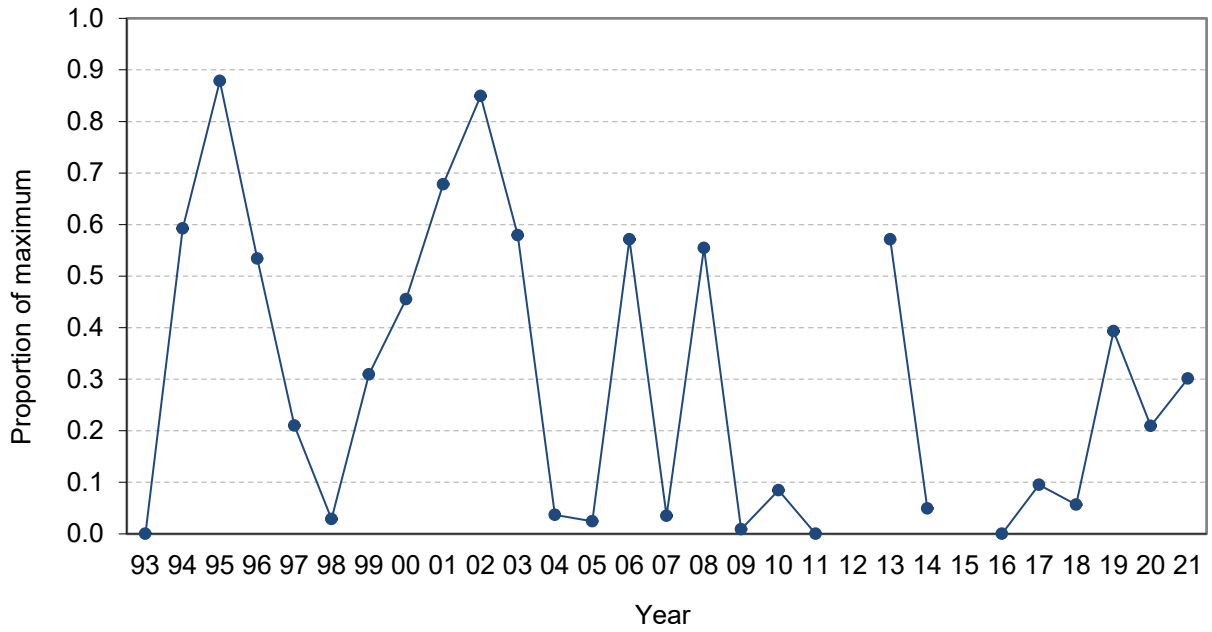

Figure 19. Number of black-legged kittiwake “fledglings” on productivity plots at East Amatuli Island, Alaska. A “fledgling” (in quotes) was determined from its presence on or after a “fledge start date” determined for each year, and from other late-season indicators, rather than by ageing from a chick-hatch date. To calculate the index for each year, counts each year were summed across plots; then this sum was divided by the sum of the among-year maximum counts for those plots. No data were collected in 2012 or 2015.

Table 20. Number of black-legged kittiwake “fledglings” on productivity plots at East Amatuli Island, Alaska. A “fledgling” (in quotes) was determined from its presence on and after a “fledge start date” determined [see Kettle (2016) for methods] for each year, and from other late-season indicators, rather than by ageing from a chick-hatch date. To calculate an index for each year, counts each year were summed across plots; then this sum was divided by the sum of the among-year maximum counts for those plots. Pre-2015 data are from Kettle (2016). Data were not collected in 2012 and 2015.

Year	Plot											Total	Proportion of maximum[a]
	1	2	3	4	5	6	7	8	9	10	11		
1993	0	0	0	-	-	-	0	0	-	-	-	0	0.00
1994	37	-	30	-	-	-	41	20	-	-	-	128	0.59
1995	58	36	34	35	40	42	51	29	45	31	25	426	0.88
1996	30	13	28	30	22	31	40	13	24	11	17	259	0.54
1997	17	4	5	6	11	16	14	8	12	3	6	102	0.21
1998	0	1	4	2	0	2	5	0	0	0	0	14	0.03
1999	17	8	16	15	26	21	12	12	13	4	6	150	0.31
2000	38	15	34	2	6	-	42	14	23	13	11	198	0.46
2001	48	35	42	22	34	26	30	24	31	20	17	329	0.68
2002	56	28	69	40	24	50	54	35	19	13	24	412	0.85
2003	41	23	57	19	12	30	22	23	20	17	17	281	0.58
2004	0	1	2	3	0	0	0	4	4	2	2	18	0.04
2005	0	0	0	3	5	0	2	1	0	1	0	12	0.02
2006	44	32	31	21	32	23	30	17	14	18	15	277	0.57
2007	4	2	0	1	7	0	0	0	3	0	0	17	0.04
2008	21	15	44	11	28	21	39	29	24	21	16	269	0.56
2009	0	0	0	-	0	0	0	0	0	4	0	4	0.01
2010	1	0	0	0	0	0	1	4	13	15	7	41	0.08
2011	0	0	0	0	0	0	0	0	0	0	0	0	0.00
2012	-	-	-	-	-	-	-	-	-	-	-	-	-
2013	33	20	49	22	20	23	28	18	27	29	8	277	0.57
2014	4	0	0	0	0	6	2	0	0	0	12	24	0.05
2015	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	0	-	-	-	-	0	0	-	-	-	0	0	0.00
2017	1	-	-	-	-	0	10	-	-	-	7	18	0.10
2018	4	-	-	3	-	0	1	-	-	-	5	13	0.06
2019	11	-	-	12	-	13	27	-	-	-	27	90	0.40
2020	7			4		13	19				5	48	0.21
2021	2	-	-	-	-	12	26	-	-	-	17	57	0.30
Max[b]	58	36	69	40	40	50	54	35	45	31	27	485	-

[a] Percent of sum of among-year maximum counts for the plots counted each year.
[b] Among-year maximum count

Table 21. Number of black-legged kittiwake chicks observed on productivity plots at East Amatuli Island, Alaska. Years not listed had data insufficient for early chick counts. Pre-2016 data are from Kettle (2016).

Year	Plot											Total	Proportion of maximum[a]
	1	2	3	4	5	6	7	8	9	10	11		
1993	0	0	0	-	-	-	0	0	-	-	-	0	0.00
1994	42	-	9	-	-	-	28	23	-	-	-	102	0.40
1995	67	42	38	38	48	50	64	37	59	35	34	512	0.90
1996	47	26	31	43	35	38	60	24	27	16	29	376	0.66
1997	27	16	7	14	14	23	19	14	20	4	10	168	0.30
1998	0	2	8	2	1	3	7	9	0	0	0	32	0.06
1999	21	11	24	19	30	26	18	17	25	6	14	211	0.37
2016	0	-	-	-	-	0	0	-	-	-	0	0	0.00
2017	3	-	-	-	-	2	16	-	-	-	-	21	0.10
2018	5	-	-	10	-	3	7	-	-	-	11	21	0.13
2019	21	-	-	16	-	18	31	-	-	-	31	117	0.23
2020	13	-	-	4	-	13	20	-	-	-	5	55	0.20
2021	7	-	-	-	-	14	34	-	-	-	25	80	0.37
Max[b]	67	42	71	43	48	51	86	46	59	35	34	512	-

[a] For each year, percent of the sum of among-year maximum counts for the plots counted that year.
[b] Among-year maximum count.

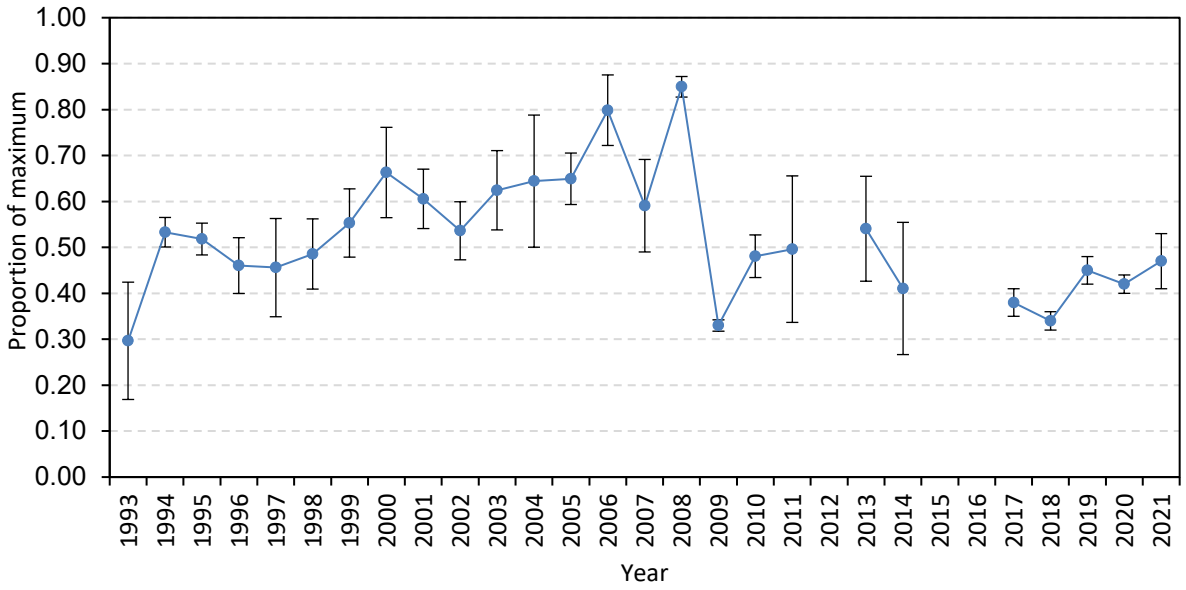

Figure 20. Annual index of counts of adult black-legged kittiwakes in productivity plots at East Amatuli Island, Alaska. The index for each year was calculated this way: (1) For each count-day (within the "census period" for that year), counts were summed across all plots counted; (2) that sum was divided by the sum of the among-year maximum counts for those plots; (3) the among-count-day proportion-of-maximum values were averaged. Error bars show one standard deviation from the mean of each year's count-day values. No data were collected in 2012 and 2015; in 2016 nest attendance was too sporadic for calculating a comparable index.

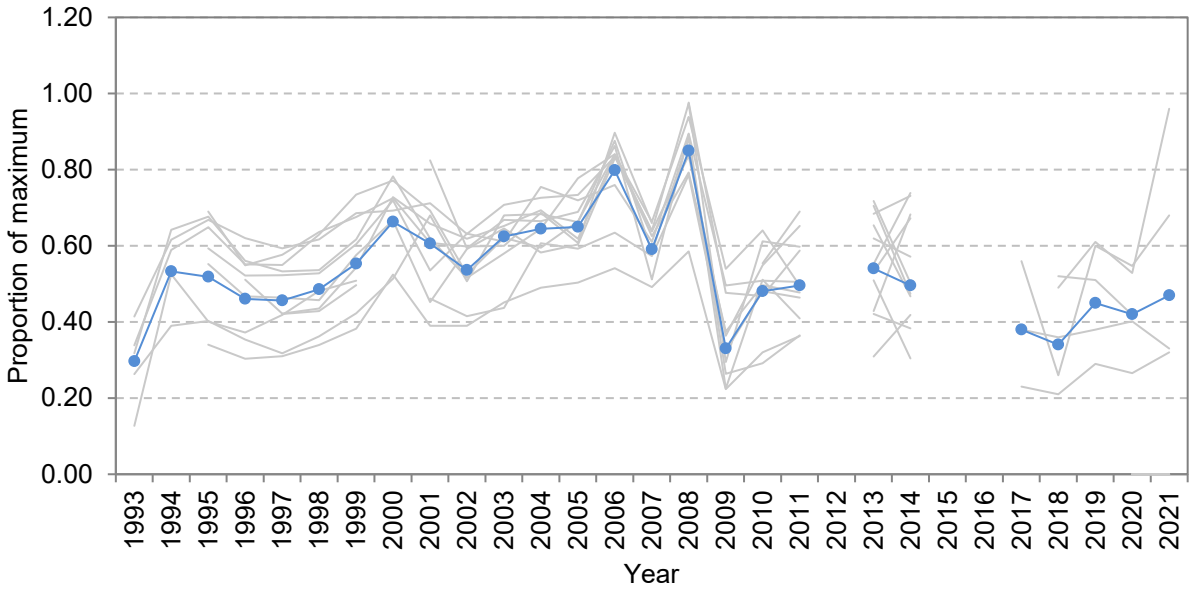

Figure 21. Annual index (in blue) of counts of adult black-legged kittiwakes in productivity plots at East Amatuli Island, Alaska. Grey lines track the number of nests counted in each of the 11 plots: For each year the plot's count of adults was divided by the among-year maximum count for that plot. The blue line is the annual index: the sum of nest-counts for all plots counted was divided by the sum of the among year maxima for the counted plots.

Table 22. Counts of adult kittiwakes on productivity plots at East Amatuli Island, Alaska in 2021. Shown are (1) each daily count for each plot counted, (2) the among-day within-"census period" mean count for each plot, (3) the among-year maximum count for that plot, (4) the sum of each day's counts, (5) the sum of among-year maximum counts for the plots counted that day, (6) the day's sum divided by the sum of the maxima, and (7) the census-period mean for those proportion-of-maximum-sums. The mean count for each plot is the point used to construct the grey lines in Figure 21. The mean proportion-of-maximum-sum is the mean point used in that figure and in Figure 20; the standard deviation in Figure 20 is calculated from the proportion-of-maximum-sums. Counts were made from the time-lapse image taken closest to 14:00.

Date	Plots[a]											Count	Maximum	
	1	2	3	4	5	6	7	8	9	10	11	sum (C)	sum (D)	C/D
1-Jul-21	45	-	-	-	-	24	42	-	-	-	31	142	280	0.51
9-Jul-21	37	-	-	-	-	21	35	-	-	-	31	124	280	0.44
17-Jul-21	40	-	-	-	-	26	43	-	-	-	38	147	280	0.53
26-Jul-21	37	-	-	-	-	26	43	-	-	-	35	141	280	0.50
3-Aug-21	39	-	-	-	-	28	41	-	-	-	31	139	280	0.50
11-Aug-21	23	-	-	-	-	17	31	-	-	-	30[b]	101	280	0.36
					-									
Mean of counts (A)	36.8	-	-	-	-	23.7	39.2	-	-	-	32.7		Mean:	0.47
Maximum for plots (B)	103	-	-	51	-	91	78	-	-	-	46		St Dev:	0.06
Mean/Maximum (A/B)	0.33	-	-	-	-	0.32	0.68	-	-	-	0.96			

[a] Productivity plots 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11 have respective field names K1-LC, K2-LC, K3-LC, K4-LC, K6-LC, K7-LC, K1-F, K2-F, K3-F, K4-F, and K5-F.

[b] Due to poor visibility on 11 Aug, this count of Plot 11 was made from a 10 Aug image.

Table 23. Proportion-of-maximum-count of adult black-legged kittiwakes in productivity plots at East Amatuli Island, Alaska. Each plot-value was calculated by dividing the mean of all census-period counts for that plot that year by the among-year maximum count for that plot. The "Total" value for each year was the mean among count-days that year of plot-sum percent-of-maximum values (rather than the mean of the annual plot-values shown in this table). Each count-day plot-sum value was the sum of the counts for all plots counted that day divided by the sum of the among-year maximum counts for those plots. Data were not collected in 2012 and 2015; in 2016 adult attendance was too sporadic for comparable counts.

	Plot											
Year	1	2	3	4	5	6	7	8	9	10	11	Total[a]
1993	-	-	-	-	-	0.13	0.41	0.34	-	-	0.32	0.30
1994	-	-	-	-	-	0.53	0.62	0.59	-	-	0.64	0.53
1995	-	0.34	0.40	0.69	0.55	0.40	0.67	0.65	0.59	-	0.68	0.52
1996	-	0.30	0.35	0.55	0.47	0.37	0.62	0.55	0.52	0.51	0.56	0.46
1997	0.42	0.31	0.32	0.58	0.46	0.42	0.59	0.55	0.52	0.42	0.53	0.46
1998	0.43	0.34	0.36	0.64	0.46	0.48	0.62	0.63	0.53	0.44	0.54	0.49
1999	0.50	0.38	0.42	0.68	0.58	0.51	0.69	0.73	0.60	0.54	0.62	0.55
2000		0.52	0.51	0.73	0.67	-	0.69	0.77	0.72	0.73	0.78	0.66
2001	0.46	0.39	0.68	0.61	0.45	0.82	0.71	0.69	0.54	0.66	0.62	0.61
2002	0.42	0.39	0.51	0.60	0.59	0.59	0.63	0.53	0.63	0.62	0.52	0.54
2003	0.44	0.45	0.68	0.60	0.65	0.67	0.71	0.62	0.61	0.65	0.58	0.62
2004	0.61	0.49	0.68	0.69	0.58	0.66	0.73	0.60	0.75	0.69	0.64	0.64
2005	0.59	0.50	0.66	0.61	0.60	0.69	0.73	0.66	0.72	0.62	0.78	0.65
2006	0.63	0.54	0.88	0.90	0.83	0.86	0.83	0.84	0.76	0.84	0.84	0.80
2007	0.57	0.49	0.58	0.66	-	0.51	0.64	0.63	0.61	0.66	0.64	0.59
2008	0.79	0.59	0.88	-	0.98	0.89	0.97	0.79	0.89	0.94	0.84	0.85
2009	0.32	0.22	0.23	-	0.48	0.26	0.29	0.38	0.50	0.54	0.36	0.33
2010	0.48	0.32	0.51	0.55	0.47	0.29	0.61	0.50	0.51	0.64	0.55	0.48
2011	0.46	0.36	0.41	0.69	0.59	0.36	0.60	0.48	0.51	0.49	0.65	0.50
2012	-	-	-	-	-	-	-	-	-	-	-	-
2013	0.42	0.31	0.55	0.65	0.43	0.51	0.71	0.62	0.53	0.68	0.72	0.54
2014	0.38	0.42	0.74	0.47	0.68	0.30	0.47	0.57	0.67	0.73	0.50	0.41
2015	-	-	-	-	-	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-	-	-	-	-	-
2017	0.38	-	-	-	-	0.23	0.56	-	-	-	-	0.38
2018	0.36	-	-	0.52	-	0.21	0.26	-	-	-	0.49	0.34
2019	0.38	-	-	0.51	-	0.29	0.60	-	-	-	0.61	0.45
2020	0.40	-	-	0.42	-	0.27	0.55	-	-	-	0.53	0.42
2021	36.8	-	-	-	-	23.7	0.68	-	-	-	0.96	0.47

[a] Only the replicates made during the year's "census period" are used for the mean.

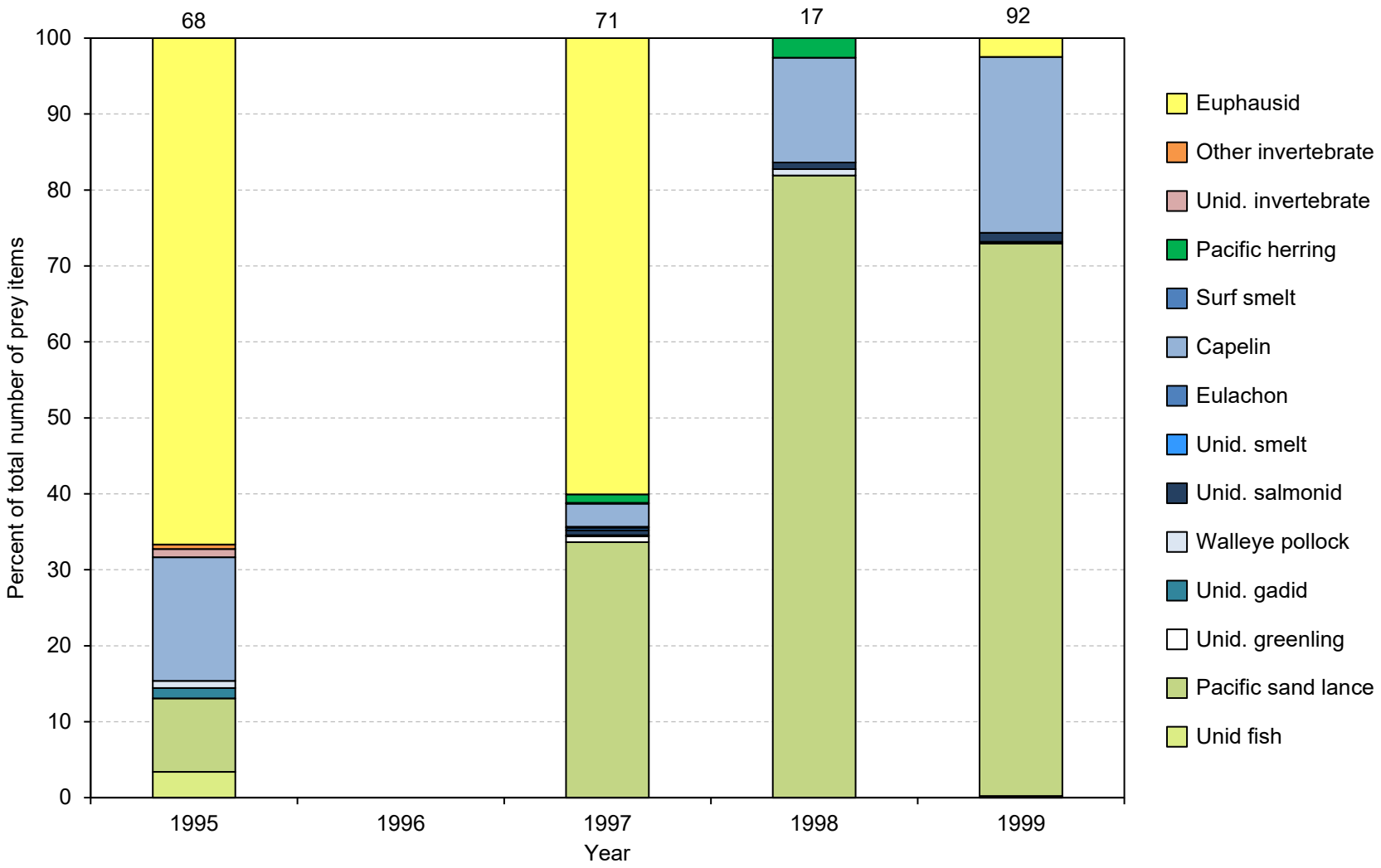

Figure 22. Species composition of prey types (for each prey type, percent of total number of items) in the diet of black-legged kittiwake chicks at East Amatuli Island, Alaska. Sample sizes atop bars are numbers of regurgitation samples. There were insufficient data in 1996.

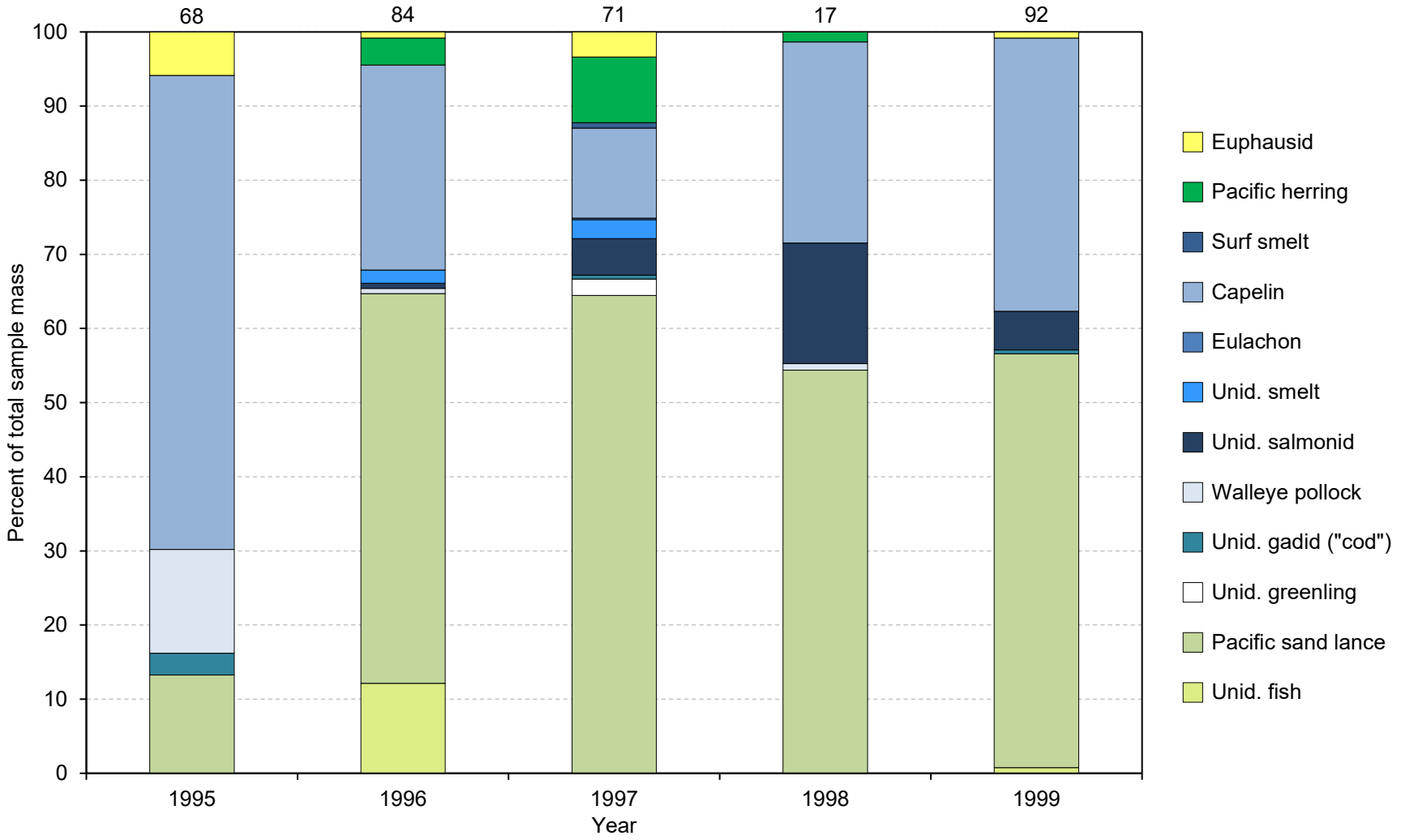

Figure 23. Biomass of prey types (for each prey type, percent of total sample mass) in the diet of black-legged kittiwake chicks at East Amatuli Island, Alaska. Sample sizes atop bars are numbers of regurgitation samples.

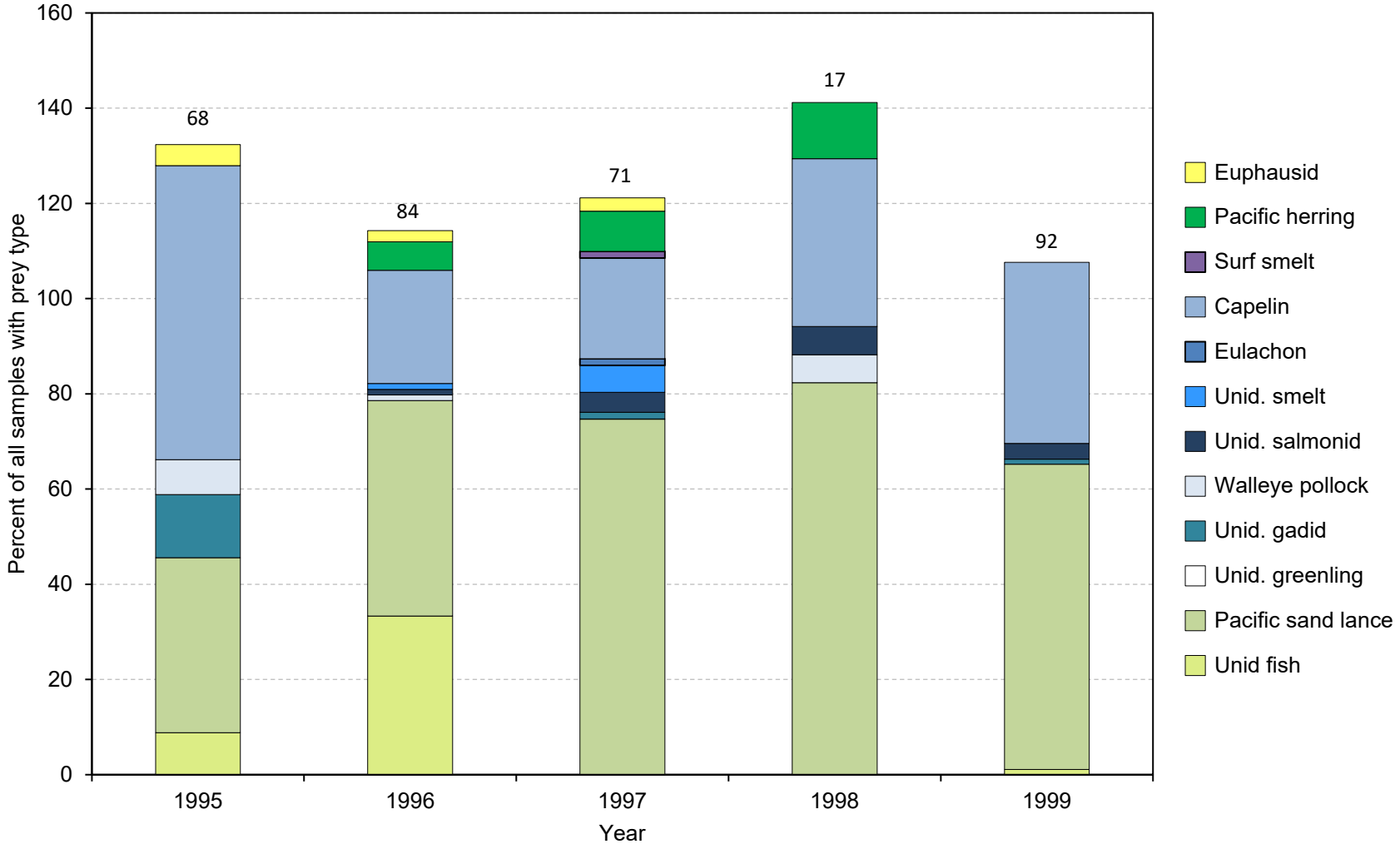

Figure 24. Frequency of occurrence of prey types (percentage of pooled samples that contained each prey type) in the diet of black-legged kittiwake chicks at East Amatuli Island, Alaska. Sample sizes atop bars are numbers of regurgitation samples.

Table 24. Species composition of prey types (for each prey type, percent of total number of items) in the diet of black-legged kittiwake chicks at East Amatuli Island, Alaska. There were insufficient data in 1996.

Prey	1995	1996	1997	1998	1999
No. samples	68	-	71	17	92
No. items	501	-	889	528	651
Invertebrates	**68.4**	**-**	**60.1**	**-**	**2.5**
Cephalopoda	**0.3**	**-**	**-**	**-**	**-**
Decabrachia	**0.3**	**-**	**-**	**-**	**-**
Unid. squid	0.3	-	-	-	-
Annelida	**0.2**	**-**	**-**	**-**	**-**
Unid. polychaete	0.2	-	-	-	-
Crustacea	**66.8**	**-**	**60.1**	**-**	**2.5**
Amphipoda	**0.2**	**-**	**-**	**-**	**-**
Unid. parathemistid	0.2	-	-	-	-
Euphausiaceae	**66.7**	**-**	**60.1**	**-**	**2.5**
Thysanoessa intermis	-	-	-	-	2.5
Unid. euphausiid	66.7	-	60.1	-	-
Unid. invertebrate	**1.1**	**-**	**-**	**-**	**-**
Fish	**31.6**	**-**	**39.9**	**100.0**	**97.5**
Clupeidae	**-**	**-**	**1.1**	**2.6**	**-**
Clupea harengus	-	-	1.1	2.6	-
Osmeridae	**16.3**	**-**	**3.6**	**13.8**	**23.1**
Hypomesus pretiosus	-	-	0.1	-	-
Mallotus villosus	16.3	-	3.0	13.8	23.1
Thaleichthys pacificus	-	-	0.1	-	-
Unid. smelt	-	-	0.3	-	-
Salmonidae	**-**	**-**	**0.7**	**0.9**	**1.2**
Unid. salmonid	-	-	0.7	0.9	1.2
Gadidae	**2.3**	**-**	**0.1**	**0.9**	**0.2**
Theragra chalcogramma	0.9	-	-	0.9	-
Unid. gadid	1.4	-	0.1	-	0.2
Hexagrammidae	**-**	**-**	**0.8**	**-**	**-**
Unid. greenling	-	-	0.8	-	-
Ammodytidae	**9.7**	**-**	**33.6**	**81.9**	**72.8**
Ammodytes personatus	9.7	-	33.6	81.9	72.8
Unid. fish	**3.4**	**-**	**-**	**-**	**0.2**

Table 25. Biomass of prey types (for each prey type, percent of total sample mass) in the diet of black-legged kittiwake chicks at East Amatuli Island, Alaska.

Prey	1995	1996	1997	1998	1999
No. samples	*68*	84	71	17	92
Total mass (g)	1557.7	2130.6	1190.5	264.7	1134.2
Invertebrates	**5.9**	**0.8**	**3.4**	**-**	**0.8**
Cephalopoda	**0.3**	**-**	**-**	**-**	**-**
Decabrachia	**0.3**	**-**	**-**	**-**	**-**
Unid. squid	0.3	-	-	-	-
Crustacea	**5.6**	**0.8**	**3.4**	**-**	**0.8**
Euphausiaceae	**5.6**	**0.8**	**3.4**	**-**	**-**
Thysanoessa intermis	-	-	-	-	0.8
Unid. euphausiid	5.6	0.8	3.4	-	-
Fish	**94.1**	**99.2**	**96.6**	**100.0**	**99.2**
Clupeidae	**-**	**3.6**	**8.9**	**1.4**	**0.0**
Clupea harengus	-	3.6	8.9	1.4	0.0
Osmeridae	**64.0**	**29.4**	**15.6**	**27.1**	**36.9**
Hypomesus pretiosus	-	-	0.7	-	-
Mallotus villosus	64.0	27.6	12.2	27.1	36.9
Thaleichthys pacificus	-	-	0.2	-	-
Unid. smelt	-	1.8	2.6	-	-
Salmonidae	**-**	**0.7**	**5.0**	**16.2**	**5.2**
Unid. salmonid	-	0.7	5.0	16.2	5.2
Gadidae	**16.9**	**0.7**	**0.5**	**0.9**	**0.5**
Theragra chalcogramma	14.0	0.7	-	0.9	-
Unid. gadid	2.9	-	0.5	-	0.5
Hexagrammidae	**-**	**-**	**0.1**	**-**	-
Unid. greenling	-	-	0.1	-	-
Ammodytidae	**13.3**	**52.6**	**64.4**	**54.4**	**55.8**
Ammodytes personatus	13.3	52.6	64.4	54.4	55.8
Unid. fish	**-**	**12.1**	**-**	**-**	**0.7**

Table 26. Frequency of occurrence of prey types (percentage of pooled samples that contained each prey type) in the diet of black-legged kittiwake chicks at East Amatuli Island, Alaska.

Prey	1995	1996	1997	1998	1999
No. samples	68	84	71	17	92
Invertebrates	**8.8**	**2.4**	**2.8**	**-**	**2.2**
Cephalopoda	**1.5**	**-**	**-**	**-**	**-**
Decabrachia	**1.5**	**-**	**-**	**-**	**-**
Unid. squid	1.5	-	-	-	-
Annelida	**1.5**	**-**	**-**	**-**	**-**
Unid. polychaete	1.5	-	-	-	-
Crustacea	**5.9**	**2.4**	**2.8**	**-**	**2.2**
Amphipoda	**1.5**	**-**	**-**	**-**	**-**
Unid. parathemistid	1.5	-	-	-	-
Euphausiaceae	**4.4**	**2.4**	**2.8**	**-**	**-**
Thysanoessa intermis	-	-	-	-	2.2
Unid. euphausiid	4.4	2.4	2.8	-	-
Fish	**100.0**	**98.8**	**100.0**	**100.0**	**98.9**
Clupeidae	**-**	**6.0**	**8.5**	**11.8**	**-**
Clupea harengus	-	6.0	8.5	11.8	-
Osmeridae	**61.8**	**25.0**	**29.6**	**35.3**	**38.0**
Hypomesus pretiosus	-	-	1.4	-	-
Mallotus villosus	61.8	23.8	21.1	35.3	38.0
Thaleichthys pacificus	-	-	1.4	-	-
Unid. smelt	-	1.2	5.6	-	-
Salmonidae	**-**	**1.2**	**4.2**	**5.9**	**3.3**
Unid. salmonid	-	1.2	4.2	5.9	3.3
Gadidae	**20.6**	**1.2**	**1.4**	**5.9**	**1.1**
Theragra chalcogramma	7.4	1.2	-	5.9	-
Unid. gadid	13.2	-	1.4	-	1.1
Hexagrammidae	**-**	**-**	**6.0**	**-**	**-**
Unid. greenling	-	-	0.1	-	-
Ammodytidae	**36.8**	**45.2**	**74.6**	**82.4**	**64.1**
Ammodytes personatus	36.8	45.2	74.6	82.4	64.1
Unid. fish	**8.8**	**33.3**	**-**	**-**	**1.1**

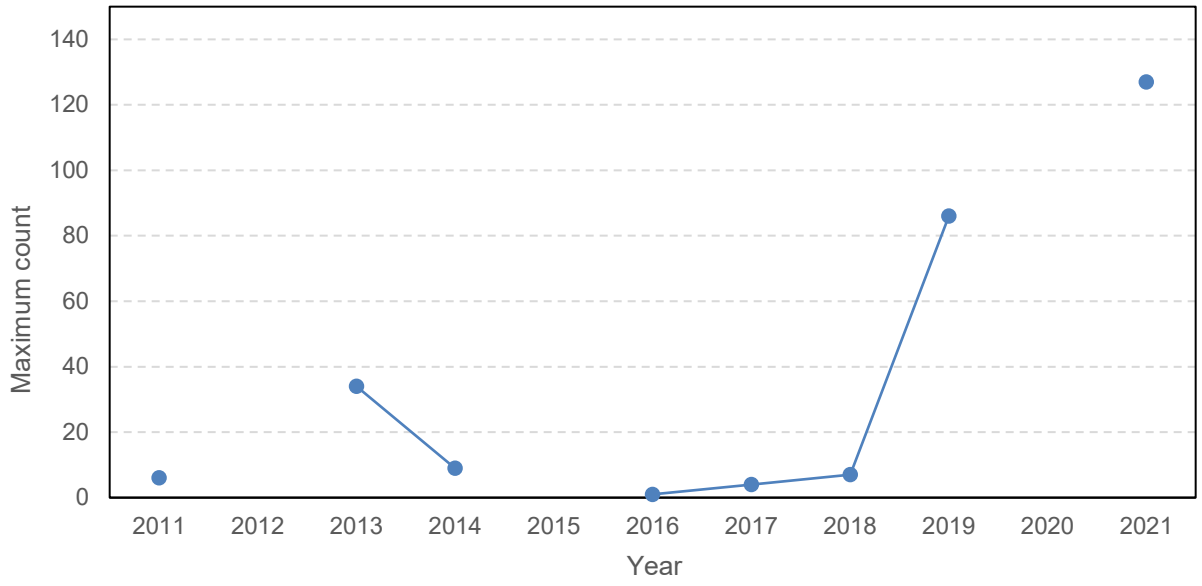

Figure 25. Maximum daily count of glaucous-winged gull fledglings on the beach at Amatuli Cove, East Amatuli Island, Alaska. Data were not collected in 2012, 2015, and 2020.

Table 27. Number of glaucous-winged gull fledglings counted on Amatuli Cove Beach, East Amatuli Island, Alaska. Dashes indicate “no data”. Data were not collected in 2012, 2015, and 2020.

Date	GWGU fledglings										
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
31 Jul	0	-	-	0	-	-	-	-	-	-	-
01 Aug	-	-	-	0	-	-	-	-	-	-	-
02 Aug	-	-	0	0	-	-	-	-	-	-	-
03 Aug	0	-	0	0	-	-	-	-	-	-	-
04 Aug	0	-	0	-	-	-	-	-	-	-	-
05 Aug	0	-	0	0	-	-	-	-	-	-	-
06 Aug	0	-	0	0	-	-	-	-	-	-	-
07 Aug	0	-	2	0	-	-	-	-	-	-	-
08 Aug	0	-	0	0	-	-	-	-	-	-	-
09 Aug	0	-	2	2	-	-	-	-	-	-	-
10 Aug	0	-	2	5	-	-	-	-	-	-	-
11 Aug	-	-	4	2	-	-	-	-	-	-	-
12 Aug	1	-	5	0	-	-	-	-	-	-	-
13 Aug	1	-	6	0	-	-	-	-	-	-	-
14 Aug	-	-	9	5	-	-	-	-	-	-	-
15 Aug	-	-	7	3	-	-	-	-	-	-	-
16 Aug	-	-	9	2	-	-	-	-	-	-	-
17 Aug	1	-	12	0	-	-	-	-	-	-	-
18 Aug	0	-	14	2	-	-	-	-	-	-	49
19 Aug	0	-	30	1	-	-	-	-	-	-	62
20 Aug	1	-	9	4	-	-	2	-	-	-	68
21 Aug	0	-	12	5	-	-	0	-	-	-	56
22 Aug	1	-	13	2	-	-	-	-	86	-	51
23 Aug	0	-	12	3	-	-	-	-	16	-	127
24 Aug	6	-	3	9	-	-	0	-	19	-	60
25 Aug	0	-	16	-	-	-	1	4	29	-	62
26 Aug	3	-	8	5	-	-	0	7	15	-	61
27 Aug	2	-	15	3	-	-	0	4	19	-	26
28 Aug	2	-	26	5	-	-	0	6	31	-	26
29 Aug	2	-	24	9	-	-	0	1	36	-	26
30 Aug	0	-	21	5	-	-	4	1	37	-	39
31 Aug	3	-	16	1	-	-	1	0	26	-	53
01 Sep	0	-	21	5	-	-	0	1	15	-	20
02 Sep	0	-	26	2	-	0	0	0	70	-	33
03 Sep	1	-	34	2	-	1	0	0	31	-	40
04 Sep	0	-	14	3	-	0	3	0	4	-	57
05 Sep	0	-	15	7	-	-	-	-	-	-	58
06 Sep	3	-	23	2	-	-	-	-	-	-	13
07 Sep	0	-	12	2	-	-	-	-	-	-	69
08 Sep	0	-	9	6	-	-	-	-	-	-	-
09 Sep	0	-	13	5	-	-	-	-	-	-	-
10 Sep	0	-	10	2	-	-	-	-	-	-	-
11 Sep	0	-	4	1	-	-	-	-	-	-	-
12 Sep	0	-	6	2	-	-	-	-	-	-	-
13 Sep	0	-	1	0	-	-	-	-	-	-	-
14 Sep	0	-	1	0	-	-	-	-	-	-	-
15 Sep	0	-	1	0	-	-	-	-	-	-	-
Maximum	6	-	34	9	-	1	4	7	86	-	127

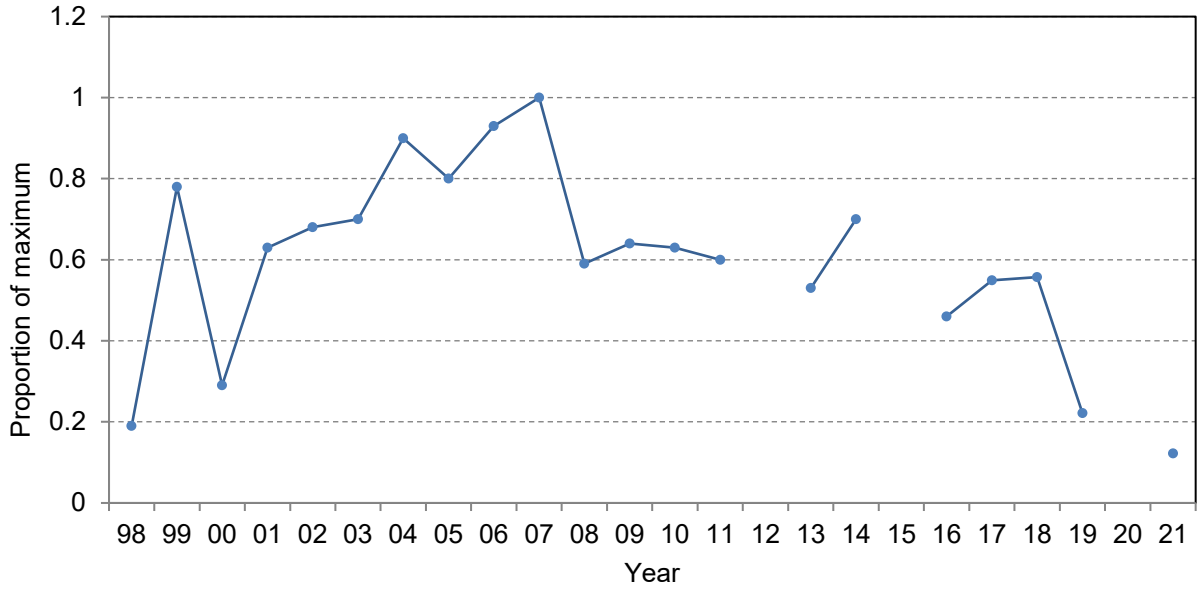

Figure 26. Number of fork-tailed storm-petrel chicks found in monitoring plots at East Amatuli Island, Alaska. Data are presented as the proportion of the among-year maximum count in Plots 1-4 and 6-11 in 2001 and Plots 1-11 in all other years. No data were collected in 2012, 2015, and 2020.

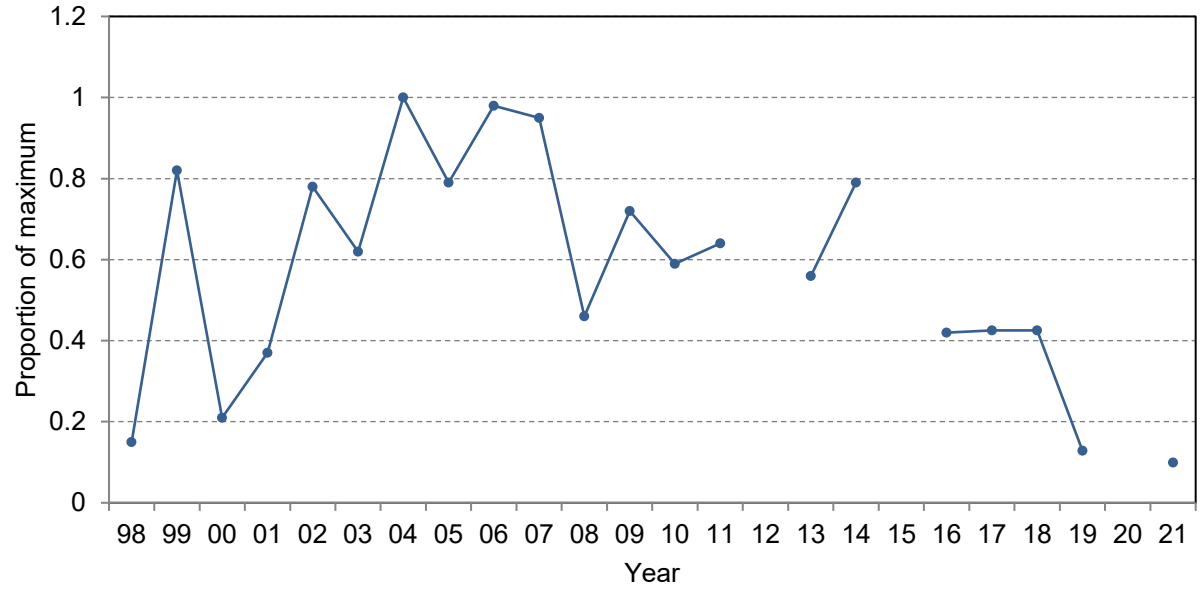

Figure 27. Number of large (mass >= 50 g) fork-tailed storm-petrel chicks found in monitoring plots at East Amatuli Island, Alaska. Data are presented as the proportion of the among-year maximum count in Plots 1-4 and 6-11 in 2001 and Plots 1-11 in all other years. No data were collected in 2012, 2015, and 2020.

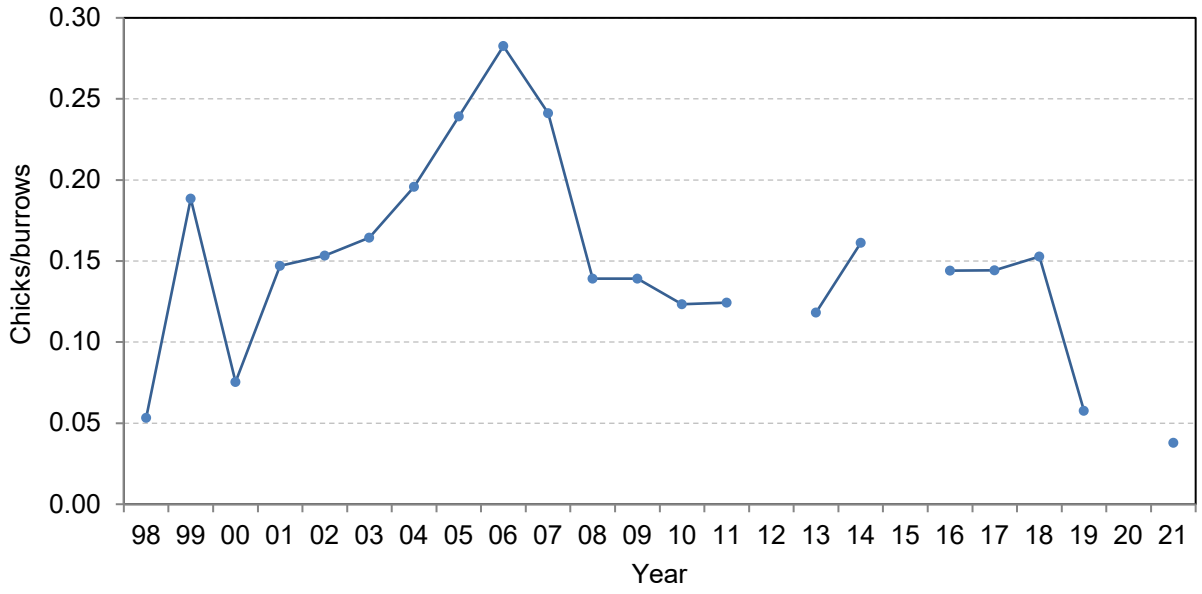

Figure 28. Proportion of burrows that contained fork-tailed storm-petrel chicks in monitoring plots at East Amatuli Island, Alaska. Data are from Plots 1-4 and 6-11 in 2001 and Plots 1-11 in all other years. No data were collected in 2012, 2015, and 2020.

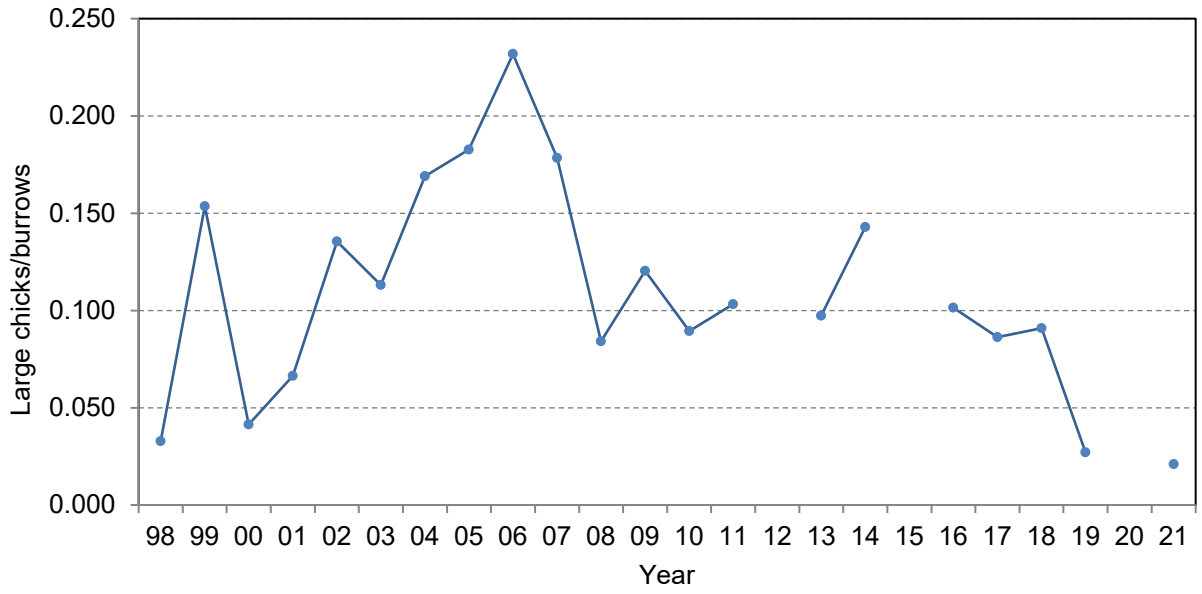

Figure 29. Proportion of burrows that contained “Large” (mass >= 50 g) fork-tailed storm-petrel chicks in monitoring plots at East Amatuli Island, Alaska. Data are from Plots 1-4 and 6-11 in 2001 and Plots 1-11 in all other years. No data were collected in 2012, 2015, and 2020.

Table 28. Number of fork-tailed storm-petrel chicks found in monitoring plots at East Amatuli Island, Alaska. Pre-2014 data are from Kettle (2014). Data were not collected in 2012, 2015, and 2020.

Year	Plot[a]											Sum of 11 plots	Prop. of max[d]	Sum w/o Plot 5	Prop. of max[e]	Prop. of max of all plots surveyed[f]
	1	2	3	4	5	6	7	8	9	10	11					
1998	1	0	1	0	3	7	2	2	1	7	2	26	0.19	23	0.18	0.19
1999	11	4	13	4	12	18	12	9	11	9	5	108	0.78	96	0.73	0.78
2000	7	2	9	1	1	8	1	2	2	6	1	40	0.29	39	0.30	0.29
2001	11	5	13	4	*no data*[b]	9	8	14	8	7	3	-	-	82	0.63	0.63
2002	7	7	16	2	4	13	10	11	9	12	3	94	0.68	90	0.69	0.68
2003	4	6	14	3	6	11	17	16	6	8	5	96	0.70	90	0.69	0.70
2004	11	9	17	4	8	19	17	18	11	6	4	124	0.90	116	0.89	0.90
2005	19	9	14	6	5	15	6	16	7	10	3	110	0.80	105	0.80	0.80
2006	16	13	17	2	11	19	11	14	14	8	3	128	0.93	117	0.89	0.93
2007	10	14	24	2	7	18	13	20	15	11	4	138	1.00	131	1.00	1.00
2008	7	8	16	2	4	8	10	10	4	9	3	81	0.59	77	0.59	0.59
2009	6	11	10	1	5	2	13	20	10	7	4	89	0.64	84	0.64	0.64
2010	6	5	6	4	3	13	14	17	7	8	4	87	0.63	84	0.64	0.63
2011	6	5	7	2	3	11	16	15	6	8	4	83	0.60	80	0.61	0.60
2012	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2013	9	3	4	2	7	7	11	9	6	10	5	73	0.53	66	0.56	0.53
2014	4	10	5	3	10	13	18	13	7	12	1	96	0.70	86	0.66	0.70
2015	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	5	2	3	4	6	8	11	6	2	15	2	64	0.46	58	0.44	0.46
2017	9	1	3	3	9	9	7	10	7	12	2	72	0.52	63	0.48	0.52
2018	8	2	5	5	6	12	7	6	3	10	1	65	0.47	59	0.45	0.47
2019	0	2	0	1	3	4	5	5	3	8	1	32	0.23	29	0.22	0.23
2020	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	4	0	3	0	2	0	2	1	4	2	0	18	0.13	16	0.12	0.13
											Max[c]	138		131		

[a] For this table plots have for this table been numbered east-to-west:1=plot “AW”; 2=“AE”; 3=“B”; 4=“EWL”; 5=“EWU”; 6=“EEL”; 7=“EEU”; 8=“DL”; 9=“DM”; 10=“DU”; 11=“F”.
[b] In 2001 plot 5 was accidentally omitted from the field surveys.
[c] Among-years maximum of sum of Plots 1-11
[d] (Sum from Plots 1-11) / (among-year maximum).
[e] (Sum from plots 1-4 and 6-11) / (among-year maximum).
[f] Proportion of among-year maximum for either plots 1-4 and 6-11 (2001) or plots 1-11 (all other years).

Table 29. Number of large (>=50 g by end of field season) fork-tailed storm-petrel chicks found in monitoring plots at East Amatuli Island, Alaska. Pre-2014 data are from Kettle (2014). Data were not collected in 2012, 2015, and 2020.

Year	Plot[a]											Sum of 11 plots	Prop. of max[d]	Sum w/o Plot 5	Prop. of max[e]	Prop. of max. of all plots surveyed[f]
	1	2	3	4	5	6	7	8	9	10	11					
1998	0	0	1	0	2	3	1	2	0	5	2	16	0.15	14	0.14	0.15
1999	8	3	13	2	8	17	8	6	9	9	5	88	0.82	80	0.79	0.82
2000	4	1	4	1	1	4	0	1	2	3	1	22	0.21	21	0.21	0.21
2001	7	4	7	2	-[b]	4	3	5	2	2	1	-	-	37	0.37	0.37
2002	5	7	14	1	4	12	9	10	9	9	3	83	0.78	79	0.78	0.78
2003	3	4	7	2	4	8	8	12	6	7	5	66	0.62	62	0.61	0.62
2004	10	8	16	3	6	15	16	16	9	4	4	107	1.00	101	1.00	1.00
2005	16	7	12	3	4	12	5	11	6	6	2	84	0.79	80	0.79	0.79
2006	8	9	14	1	10	18	11	14	12	5	3	105	0.98	95	0.94	0.98
2007	6	10	17	2	5	15	8	16	12	8	3	102	0.95	97	0.96	0.95
2008	5	6	8	1	2	4	7	5	3	6	2	49	0.46	47	0.47	0.46
2009	6	9	9	1	4	2	13	16	8	7	2	77	0.72	73	0.72	0.72
2010	5	4	3	3	2	10	12	10	5	6	3	63	0.59	61	0.60	0.59
2011	5	4	6	2	2	10	13	13	5	5	4	69	0.64	67	0.66	0.64
2012	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2013	7	3	4	2	6	6	9	8	3	8	4	60	0.56	54	0.53	0.56
2014	4	10	5	2	9	13	16	13	5	7	1	85	0.79	76	0.75	0.79
2015	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	4	2	2	2	3	6	8	6	2	9	1	45	0.42	42	0.42	0.42
2017	6	1	3	1	6	6	5	9	6	5	2	50	0.47	44	0.44	0.47
2018	7	1	5	3	4	10	6	6	1	6	1	50	0.47	46	0.46	0.47
2019	0	1	0	0	2	1	4	4	1	4	0	17	0.16	15	0.15	0.16
2020	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	3	0	2	0	0	0	1	1	2	1	0	10	0.09	10	0.10	0.09
											Max[c]	107		101		

[a] Plots have for this table been numbered east-to-west:1=Plot “AW”; 2=“AE”; 3=“B”; 4=“EWL”; 5=“EWU”; 6=“EEL”; 7=“EEU”; 8=“DL”; 9=“DM”; 10=“DU”; 11=“F”.

[b] In 2001 plot 5 was accidentally omitted from the field surveys.

[c] Among-years maximum of sum of Plots 1-11

[d] (Sum from Plots 1-11) / (among-year maximum).

[e] (Sum from plots 1-4 and 6-11) / (among-year maximum).

[f] Proportion of among-year maximum for either plots 1-4 and 6-11 (2001) or plots 1-11 (all other years).

Table 30. Indices for fork-tailed storm-petrel reproductive success (proportion of burrows that contain chicks, proportion of burrows with “Large” chicks, and proportion of chicks that survive to “Large” size) from monitoring plots at East Amatuli Island, Alaska. Pre-2014 data are from Kettle (2014). No data were collected in 2012, 2015, and 2020.

Parameter	1998	1999	2000	2001[a]	2002	2003	2004	2005	2006	2007	2008	2009
Burrows (a)	488	573	531	558	613	584	633	460	453	572	582	640
Burrows with a chick (b)	26	108	40	82	94	96	124	110	128	138	81	89
Burrows with a chick weighed[b] (c)	26	106	35	54	89	84	113	94	118	113	70	81
Burrows that produced a “large” (mass > 50 g) chick (d)	16	88	22	37	83	66	107	87	105	102	49	77
Burrows with chick < 50 g at end of field season (e)	7	14	15	23	7	19	6	3	11	9	25	5
Proportion of burrows with a chick (b/a)	0.05	0.19	0.08	0.15	0.15	0.16	0.20	0.24	0.28	0.24	0.14	0.14
Proportion of burrows that contain a “large” chick (d/a)	0.03	0.15	0.04	0.07	0.14	0.11	0.17	0.19	0.23	0.18	0.08	0.12
Proportion of chicks that survived to “large” size ((d-e)/(c-e))	0.47	0.80	0.35	0.45	0.93	0.72	0.94	0.92	0.88	0.89	0.53	0.95

Table 30 (years continued).

Parameter	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Burrows (a)	705	668	-	617	595	-	444	568	517	555	-	475
Burrows with a chick (b)	87	83	-	73	96	-	64	82	79	32	-	18
Burrows with a chick weighed[b] (c)	66	73	-	63	85	-	45	50	52	27	-	12
Burrows that produced a “large” (mass > 50 g) chick (d)	63	69	-	60	85	-	45	49	47	15	-	10
Burrows with chick < 50 g at end of field season (e)	2	5	-	3	1	-	0	1	4	10	-	2
Proportion of burrows with a chick (b/a)	0.12	0.12	-	0.12	0.16	-	0.14	0.14	0.15	0.06	-	0.04
Proportion of burrows that contain a “large” chick ((d/a)	0.09	0.10	-	0.10	0.14	-	0.10	0.09	0.09	0.03	-	0.02
Proportion of chicks that survived to “large” size ((d-e)/(c-e))	0.95	0.94	-	-[c]	-	-	-	-	-	-	-	-

[a] One plot was inadvertently omitted from field work in 2001; data are for 10 plots rather than all eleven.

[b] Each year there was a small proportion of chicks that either could not be measured or were alive but had not yet reached 50 g when we departed from the island. The calculation for fledging success omits those nests.

[c] After 2011 burrow checks began later in the nestling season than in previous years. Nestling survival therefore is not comparable with that of previous years and so has not been included in the table

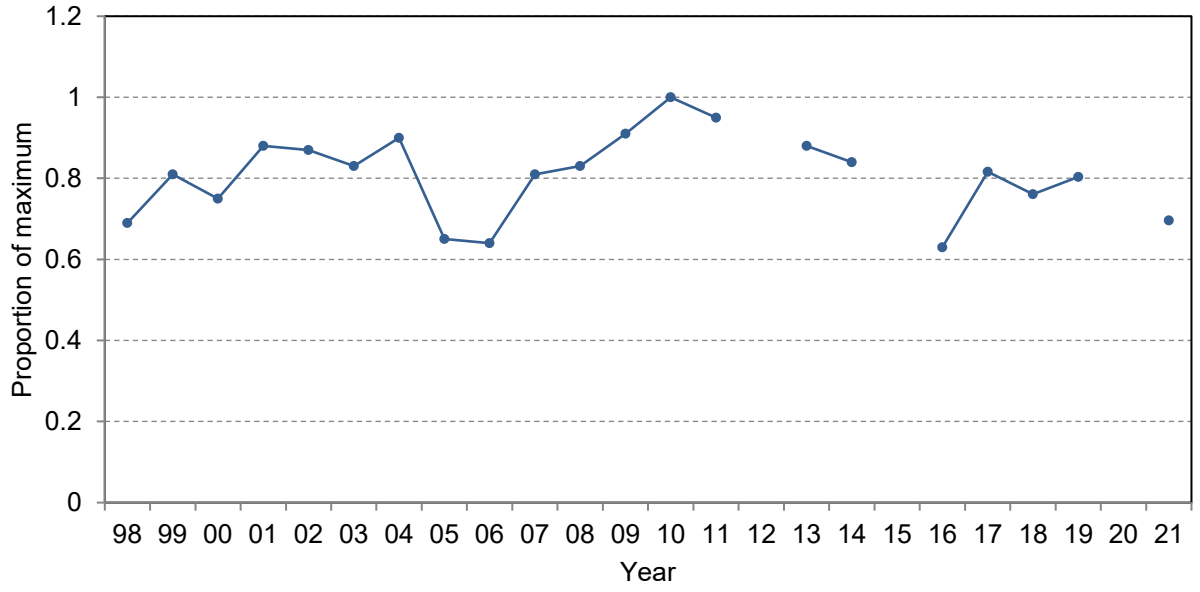

Figure 30. Number of burrows counted in fork-tailed storm-petrel plots at East Amatuli Island, Alaska. Data are presented as the proportion of the among-year maximum count in Plots 1-4 and 6-11 (2001) and Plots 1-11 (all other years). Data were not collected in 2012, 2015, and 2020.

Table 31. Number of burrows counted in fork-tailed storm-petrel monitoring plots at East Amatuli Island, Alaska. Pre-2014 data are from Kettle (2014). Data were not collected in 2012 and 2015.

Year	Plot[a]											Sum of 11 plots	Prop. of max[d]	Sum w/o Plot 5	Prop. of max[e]	Prop. of max. combined[f]
	1	2	3	4	5	6	7	8	9	10	11					
1998	50	45	47	16	58	72	79	18	61	24	18	488	0.69	430	0.68	0.69
1999	53	49	48	25	64	79	92	69	25	55	14	573	0.81	509	0.80	0.81
2000	44	43	51	24	54	79	82	58	27	54	15	531	0.75	477	0.75	0.75
2001	53	51	52	25	-[b]	80	98	86	36	64	13	-	-	558	0.88	0.88
2002	52	49	44	24	55	80	105	80	38	71	15	613	0.87	558	0.88	0.87
2003	51	44	35	20	64	77	72	86	38	81	16	584	0.83	520	0.82	0.83
2004	63	57	43	35	69	73	93	88	32	67	13	633	0.90	564	0.89	0.90
2005	48	45	37	19	53	63	76	52	26	44	6	460	0.65	406	0.64	0.65
2006	49	43	37	22	49	66	90	55	32	38	12	453	0.64	399	0.63	0.64
2007	47	55	48	23	57	69	85	86	31	58	13	572	0.81	515	0.81	0.81
2008	45	40	45	37	55	77	87	93	30	61	12	582	0.83	527	0.83	0.83
2009	53	53	35	38	56	74	108	107	36	64	16	640	0.91	584	0.92	0.91
2010	58	64	44	41	70	93	123	92	37	71	12	705	1.00	635	1.00	1.00
2011	57	50	37	29	74	87	113	91	35	79	16	668	0.95	594	0.94	0.95
2012	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2013	50	60	35	28	69	86	101	81	28	61	19	617	0.88	548	0.86	0.88
2014	54	47	24	26	55	73	109	92	39	64	12	595	0.84	540	0.85	0.84
2015	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	47	37	23	17	35	45	71	60	26	70	13	444	0.63	409	0.64	0.63
2017	60	41	29	28	66	91	72	77	30	58	15	567	0.80	501	0.81	0.80
2018	53	42	25	24	49	94	59	75	24	61	11	517	0.73	423	0.67	0.73
2019	57	43	22	28	61	86	69	71	30	72	8	547	0.78	461	0.73	0.78
2020	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	42	36	27	25	47	82	62	60	27	58	9	475	0.67	393	0.62	0.67
											Max[c]	705		635		

[a] Plots have for this table been numbered east-to-west:1=Plot “AW”; 2=“AE”; 3=“B”; 4=“EWL”; 5=“EWU”; 6=“EEL”; 7=“EEU”; 8=“DL”; 9=“DM”; 10=“DU”; 11=“F”.

[b] In 2001 plot 5 was accidentally omitted from the field surveys.

[c] Among-years maximum of sum of Plots 1-11

[d] (Sum from Plots 1-11) / (among-year maximum).

[e] (Sum from plots 1-4 and 6-11) / (among-year maximum).

[f] Proportion of among-year maximum for either plots 1-4 and 6-11 (2001) or plots 1-11 (all other years).

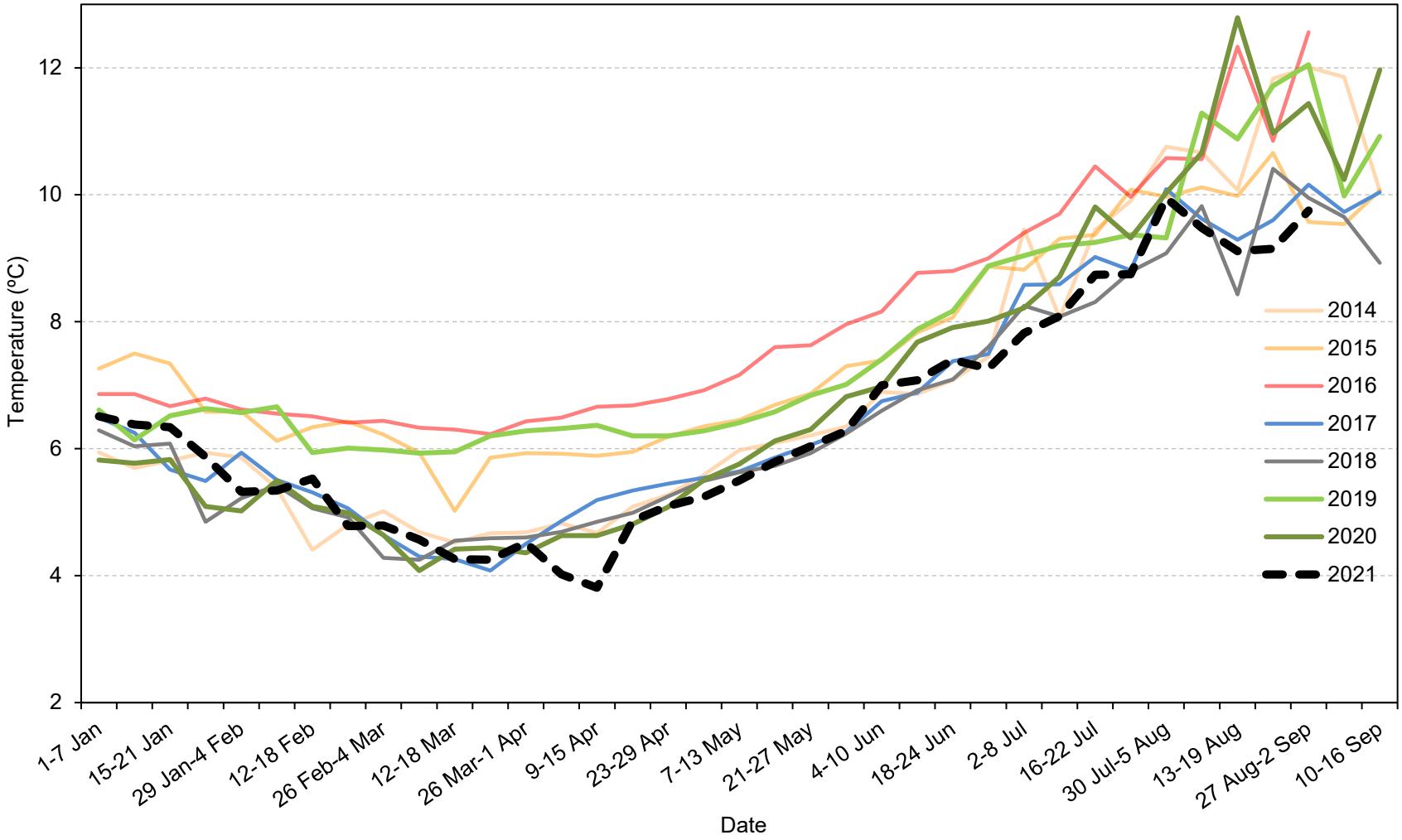

Figure 31. Mean weekly sea surface temperature (°C) at East Amatuli Island, Alaska during 2014-2021.

Table 32. Weekly mean of daily means of hourly sea surface temperature (°C) at East Amatuli Island, Alaska.

Week		2014	2015	2016	2017	2018	2019	2020	2021
01 Jan -	07 Jan	5.9	7.3	6.9	6.5	6.3	6.6	5.8	6.5
08 Jan -	14 Jan	5.7	7.5	6.9	6.3	6.0	6.1	5.8	6.4
15 Jan -	21 Jan	5.8	7.3	6.7	5.7	6.1	6.5	5.8	6.3
22 Jan -	28 Jan	5.9	6.6	6.8	5.5	4.9	6.6	5.1	5.9
29 Jan -	04 Feb	5.9	6.6	6.6	5.9	5.2	6.6	5.0	5.3
05 Feb -	11 Feb	5.4	6.1	6.6	5.5	5.4	6.7	5.5	5.3
12 Feb -	18 Feb	4.4	6.3	6.5	5.3	5.1	5.9	5.1	5.5
19 Feb -	25 Feb	4.8	6.4	6.4	5.1	4.9	6.0	5.0	4.8
26 Feb -	04 Mar	5.0	6.2	6.4	4.6	4.3	6.0	4.6	4.8
05 Mar -	11 Mar	4.7	5.9	6.3	4.3	4.3	5.9	4.1	4.6
12 Mar -	18 Mar	4.5	5.0	6.3	4.3	4.6	6.0	4.4	4.3
19 Mar -	25 Mar	4.7	5.9	6.2	4.1	4.6	6.2	4.4	4.3
26 Mar -	01 Apr	4.7	5.9	6.4	4.5	4.6	6.3	4.4	4.5
02 Apr -	08 Apr	4.8	5.9	6.5	4.9	4.7	6.3	4.6	4.0
09 Apr -	15 Apr	4.7	5.9	6.7	5.2	4.9	6.4	4.6	3.8
16 Apr -	22 Apr	5.1	6.0	6.7	5.3	5.0	6.2	4.8	4.9
23 Apr -	29 Apr	5.3	6.2	6.8	5.5	5.3	6.2	5.1	5.1
30 Apr -	06 May	5.6	6.4	6.9	5.5	5.5	6.3	5.5	5.2
07 May -	13 May	6.0	6.5	7.2	5.6	5.6	6.4	5.8	5.5
14 May -	20 May	6.1	6.7	7.6	5.9	5.7	6.6	6.1	5.8
21 May -	27 May	6.2	6.9	7.6	6.1	5.9	6.8	6.3	6.0
28 May -	03 Jun	6.3	7.3	8.0	6.3	6.2	7.0	6.8	6.3
04 Jun -	10 Jun	6.9	7.4	8.2	6.8	6.6	7.4	7.0	7.0
11 Jun -	17 Jun	6.9	7.8	8.8	6.9	6.9	7.9	7.7	7.1
18 Jun -	24 Jun	7.1	8.1	8.8	7.4	7.1	8.2	7.9	7.4
25 Jun -	01 Jul	7.4	8.9	9.0	7.5	7.6	8.9	8.0	7.3
02 Jul -	08 Jul	9.5	8.8	9.4	8.6	8.3	9.0	8.2	7.8
09 Jul -	15 Jul	8.1	9.3	9.7	8.6	8.1	9.2	8.7	8.1
16 Jul -	22 Jul	9.4	9.4	10.5	9.0	8.3	9.3	9.8	8.7
23 Jul -	29 Jul	9.9	10.1	10.0	8.8	8.8	9.4	9.3	8.8
30 Jul -	05 Aug	10.8	10.0	10.6	10.1	9.1	9.3	10.0	10.0
06 Aug -	12 Aug	10.7	10.1	10.6	9.6	9.8	11.3	10.7	9.5
13 Aug -	19 Aug	10.1	10.0	12.3	9.3	8.4	10.9	12.8	9.1
20 Aug -	26 Aug	11.8	10.7	10.9	9.6	10.4	11.7	11.0	9.2
27 Aug -	02 Sep	12.0	9.6	12.6	10.2	10.0	12.1	11.4	9.8
03 Sep -	09 Sep	11.9	9.5	-	9.7	9.7	10.0	10.2	-
10 Sep -	16 Sep	10.1	10.1	-	10.0	8.9	10.9	12.0	-

Table 33. History of seabird reconnaissance and monitoring at East Amatuli Island.

Years	Activity
1974-1975	Pre-Refuge biological reconnaissance of Barren Islands by Edgar Bailey.
1976-1979	University of Washington (UW) Outer Continental Shelf Environmental Assessment Program (OCSEAP) biological studies for determining pre-oil-development status of colonies.
1980-1984	Brief UW visits to study fork-tailed storm-petrel biology.
1985-1989	Brief annual visits by Alaska Maritime National Wildlife Refuge (AMNWR) for monitoring mainly burrow-nesting seabirds.
1990-1992	AMNWR post-*Exxon Valdez* Oil Spill boat-based common murre “Damage Assessment”.
1990-1993	June-Sept UW post-Oil Spill Damage Assessment and Restoration Monitoring for the common murre; other seabird species also studied.
1993-1999	June-Sept AMNWR post-Oil Spill Damage Assessment and Restoration Monitoring for the common murre; other seabird species also monitored.
1995-1999	Barren Islands seabird component of *Exxon Valdez* Trustee Council’s Alaska Predator Ecosystem Experiment (APEX) project conducted by AMNWR June-Sept each year.
2000-2014	(Except 2012) July-Sept annual seabird monitoring by AMNWR.
2015	Two-hour visit on 2 September to observe whether murre and kittiwakes bred; no field camp season.
2016	Time-lapse cameras monitored cliff-nesters; storm-petrel and tufted puffin plots surveyed. Eleven-day field camp ending on 5 September.
2017	Time-lapse cameras monitored cliff-nesters and tufted puffins; storm-petrel and tufted puffin plots surveyed. Nineteen-day field camp ending on 5 September.
2018	Time-lapse cameras monitored cliff-nesters and tufted puffins; storm-petrel and tufted puffin plots surveyed. Sixteen-day field camp ending on 5 September.
2019	Time-lapse cameras monitored cliff-nesters and tufted puffins; storm-petrel and tufted puffin plots surveyed. Sixteen-day field camp ending on 5 September.
2020	Time-lapse cameras monitored cliff-nesters and tufted puffins. No field camp; storm-petrel and tufted puffin plots not surveyed.
2021	Time-lapse cameras monitored cliff-nesters and tufted puffins; storm-petrel and tufted puffin plots surveyed. Twenty-three-day field camp ending on 8 September.