AMNWR 05/19

BIOLOGICAL MONITORING AT BULDIR ISLAND, ALASKA IN 2004: SUMMARY APPENDICES

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Key words: *Aethia cristatella*, *Aethia psittacula*, *Aethia pusilla*, *Aethia pygmaea*, Aleutian Islands, black-legged kittiwake, breeding chronology, Buldir Island, crested auklet, food habits, fork-tailed storm-petrel, *Fratercula cirrhata, Fratercula corniculata*, glaucous-winged gull, horned puffin, *Larus glaucescens*, Leach's storm-petrel, least auklet, *Oceanodroma furcata*, *Oceanodroma leucorhoa*, parakeet auklet, pelagic cormorant, *Phalacrocorax pelagicus*, populations, productivity, red-legged kittiwake, *Rissa brevirostris*, *Rissa tridactyla*, thick-billed murre, tufted puffin, reproductive success, survival, *Uria lomvia*, whiskered auklet

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September 2005

Cite as: M.A. Barrett, E.M. Andersen, Murphy, M.A., and S.F. Sapora. 2005. Biological monitoring at Buldir Island, Alaska in 2004: Summary appendices. U.S. Fish and Wildl. Serv. Rep. AMNWR 05/19. Homer, Alaska. 126 pp.

" I should mention also the great scientific value [of Buldir]; a strictly isolated island with an isolated fauna in which the elements may interact unhindered. This will be of great value and interest to the biologist of the future"

- Olaus Murie, 1936
  in Biological investigations of the Aleutian Islands and southwestern Alaska

"We were a weather station, but in reality we soon realized that they did not care about our weather reports. They were getting them from other places, but if we failed to come on the air they could assume the Japanese had returned…Our group [of 5] which was there for 7 months had to have the other radio operator relieved. Went a bit balmy and we were afraid he was going to take a gun to us…"

- Dave Grehl, 1943
  U.S. Army weatherman stationed on Buldir Island

"The cliffs of Buldir are forbidding; marine erosion is rapidly and steadily removing the island by peripheral attack."

- Robert Coats, 1953
  in The Geology of Buldir Island, Alaska

"We hope the weather gods allow a landing [at Buldir]"

- Robert D. Jones, 1961
  Refuge Manager, Aleutian Islands National Wildlife Refuge

"It is the writer's intent to convey the impression of land, sea, and sky alive with birds in all of their activities. Such a concentration of birds produces an immense volume of sound. Add to this the grunting and roaring of about 10,000 Steller's sea lions and you have the *bedlam of Buldir*."

- Robert D. Jones, ~1964
  Refuge Manager, Aleutian Islands National Wildlife Refuge

"Every blade of grass [on Buldir] holds a quart of water…"

- G. Vernon Byrd, 1975
  Quote from the film *Chain of Life*

East cape, Buldir viewed from the seabird productivity plots at Spike camp.

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INTRODUCTION

The Alaska Maritime National Wildlife Refuge (AMNWR) annually monitors selected species of seabirds at nine ecological monitoring sites throughout Alaska. The objective of this long term program is to collect baseline status and trend information for a suite of species representing piscivorous and planktivorous trophic guilds. Members of these guilds include species which feed in both nearshore and offshore waters and include key species that serve as indicators of ecosystem health. Many of these species such as puffins (*Fratercula* spp.), kittiwakes (*Rissa* spp.), auklets (*Aethia* spp.), and murres (*Uria* spp.) are particularly well suited as indicators of fluctuations in the marine food web. By correlating 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 in assessing effects of management.

Seabirds at Buldir Island, one of the nine monitoring sites, have been studied annually since 1988 when intensive season-long monitoring began. Historical data exists from as early as 1974, particularly for storm-petrels and auklets, and these are used for comparison purposes. Buldir is unique among Aleutian Islands in that it escaped the widespread introduction of arctic foxes (Bailey 1993) and rats, both of which apply heavy predation pressure on breeding seabirds. The island's isolation and difficulty of access, as well as the absence of non-native predators, have made Buldir the most diverse (21 nesting species) and probably largest seabird colony in Alaska (perhaps 4,000,000 individuals; Byrd 1978, Byrd and Day 1986, Byrd and Williams 1994).

The specific monitoring goals in 2004 were to estimate: 1) hatching chronology for red-legged and black-legged kittiwakes; tufted and horned puffins; and thick-billed murres, 2) reproductive success indices for all species including pelagic cormorants and glaucous-winged gulls, 3) food habits data for storm-petrels, kittiwakes, auklets, and puffins, and 4) survival data for adult red-legged kittiwakes.

Detailed results of the 2004 monitoring program are contained in these appendices and archived at the Refuge headquarters in Homer, Alaska. Summary data were entered into the Pacific Seabird Monitoring Database and will be included in the Consolidated Seabird Monitoring report of the Alaska Maritime National Wildlife Refuge.

STUDY AREA

Buldir Island (52°21' N, 176°56' E) is the westernmost island in the Rat Islands group of the Aleutian chain. This 2000-ha island is approximately 6.4 km long and 3.2 km wide. Located about 110 km from both Shemya to the west and Kiska to the east, it is the most isolated island in the Aleutians, providing the only landfall in a 220 km-wide pass.

The weather is typical of a northern maritime climate, with moderate year-round temperatures and strong winds. Fog and rain are characteristic, and violent storms occur frequently. The average temperature at sea level is about 7.7°C in the summer and 3.7°C annually. Precipitation averages 80.6 cm annually. Snow accumulation at sea level rarely exceeds 0.5 m, however passes and higher elevations can have drifts in excess of 10m. There is no permafrost. (Data for Shemya Island from Western Region Climate Center).

Buldir Island is a few thousand years old and composed of basalts and basaltic andesites from two volcanic cones: the older Buldir Volcano and newer East Cape Volcano. These two volcanic centers, each of which had two main eruptive periods, were separated by considerable time and later subjected to intense marine erosion continuing to the present day. There are no historic records of eruptions and the island is considered inactive. Only portions of each volcano remain today.

The highest point on the island, Buldir Eccentric (655m), is part of a rim of an old summit tuff cone of Buldir Volcano. The center of the volcano, only a remnant of which is left today, was about 800m in

diameter and centered about 800m south of Buldir Eccentric's summit. Glissade Valley is a fault line that separates the older portion of Buldir Volcano, represented by Buldir Eccentric, from the later parasitic cone of Buldir Volcano known today as Owl Knob. Kittiwake Lake is not the main crater of this later parasitic cone, but rather a small maar blasted from the side of the cone. Most of the main part of Owl Knob was eroded prior to the later eruption of East Cape Volcano. The rocks of Buldir Volcano are chiefly olivine basalts and olivine hypersthene basalts.

The East Cape Volcano consists of two parts: the older principle eruptive center of Slide Mountain and a smaller flank eruption volcanic dome of Round Mountain. Round Mountain is the most recent manifestation of eruptive activity on the island. Much of the cone of East Cape Volcano is mantled by a chaotic crumble breccia derived from the underlying plug dome of hypersthene-bearing hornblende basalts and basaltic andesites. This chaotic crumble breccia, a mixture of boulders in a dirt matrix, is especially evident at beach cliffs that are actively undergoing marine erosion. The northern portion of Slide Mountain is believed to have slid into the ocean during one of many earthquakes. The high ridgeline of East Cape sweeps northeasterly off the flanks of Round Mountain and is believed to be a lava flow now nearly removed by erosion.

There are only two areas of alluvial deposit on Buldir because of its mountainous nature and incessant marine erosion. The primary area is the valley containing North Marsh and South Marsh. This flat area is composed of sand, gravel, reworked cinders and ash and is retreating rapidly as evidenced by its vertical cliff face at the beach. At the time of deposition this area was most likely protected by now eroded portions of Buldir Volcano and its parasitic cone (Owl Knob). The other area is an area known as "The Dip" which was formed by material collected behind a bar formed by a landslide off Round Mountain (all geologic information from Coats 1953).

Vegetation on the island is composed of two distinct plant complexes: lowland tall-plant and upland short-plant (Byrd 1984). The lowland tall-plant complex is found generally below 300m and contains eight recognizable plant communities, over 90% of which consists of only three communities *Elymus*-umbel, *Elymus*-umbel-fern, and *Carex*-fescue meadow. The lowland short-plant complex is composed of four communities of which the moss-willow tundra is most widespread. Over 119 plants have been identified on the island – fewer than on most other Aleutian Islands. There are no erect trees or shrubs.

Buldir Island is surrounded by deep water and is representative of a pelagic seabird colony where prey is diverse and availability is variable among years (Springer et al. 1996). Most prey species taken by birds are members of the Oceanic and Outer-shelf Zooplankton community (Cooney 1981), or are deep-dwelling vertical migrants (e.g. squid and Myctophids). The shallow water surrounding Buldir, Middle and Tahoma reefs to the southeast and south serve as surrogate meso-scale continental shelf-like habitats for coastal marine fauna in this otherwise deep water environment. The three reefs are important feeding areas for many birds breeding on Buldir (Dragoo and Byrd 1999). In particular, the juxtaposition of the Buldir reef escarpment (60-100m) to the Buldir Depression, an 18x55 km basin with depths to 2000 m, creates a physiographic structure conducive to foraging by a wide variety of seabirds. Sea surface temperatures measured in North Bight are normally 3-4^{o} C in late May and rise to 5-6^{o} C in August. Occasionally, anomalous events occur such as in 1998 when sea surface temperature rose to an unusually high 12^{o} C.

Humans have occupied Buldir since at least 800 AD. The midden site on North Bight Beach is large and contains evidence of substantial-sized houses. Although there was a relatively long period of use in the late prehistoric period, occupation of the site was typically intermittent with long breaks between uses. According to Corbett et al. (1997), it is unclear why Aleuts used Buldir at all. The site does not appear to have been a seasonal hunting camp in an annual subsistence cycle and the resources were not unusually rich. Inhabitants fed mainly on Steller's sea lions. Large numbers of birds, primarily alcids, were taken by inhabitants for food, clothing or decorations on clothing.

Buldir has been designated a federal Research Natural Area (RNA). RNAs are reserves where natural processes are allowed to dominate and where management is designed to preserve a given ecosystem or feature. There are three characteristics shared by most RNAs: 1) minimal human interference and a

reasonable assurance of long-term existence, 2) the availability of diverse or multiple data sets for analysis of factor interrelationships or temporal sequences, and 3) the association of scientists of different disciplines leading toward scientific discoveries unlikely to occur without such association.

Buldir is also a component of the Aleutian Islands Biosphere Reserve under UNESCO's Man and the Biosphere program (MAB). Biosphere reserves are areas intended to conserve the diversity and integrity of biotic plants and animals in the natural ecosystem and to safeguard their genetic diversity. Biosphere Reserves also provide areas for ecological and environmental research and baseline studies.

METHODS

Personnel— Martin Murphy (camp leader) and Slade Sapora, (biological technician) were present on Buldir in 2005 from 26 May through 25 August. Ian Jones and Dan Roby participated in observations and directed auklet resighting efforts from 26 May to 7 June. John Citta and Joe Seyfried (26 May through 25 August) conducted work on a special project looking at fatty acids and corticosteroid levels in seabirds known as ReFer II directed by Alan Springer, Sara Iverson, and Sasha Kitaysky.

Data Collection and Analysis.—We followed data collection and analysis methods as outlined in Williams *et al*. (2002). Food habits data for 2000, 2001, 2002, 2003, and 2004 were not analyzed in time to be included in this report. A separate report containing food habits data from all AMNWR sites may be issued. Except for a single count at Middle Rock, population counts were not conducted in 2004; data from 2003 are presented. Additionally, no point count or pigeon guillemot survey was conducted in 2004; previous data are presented.

ACKNOWLEDGMENTS

This monitoring program would not exist without the guiding influences and visions of Vernon Byrd and Jeff Williams who have tirelessly shaped and molded the program over the years. We would also like to thank all other staff members of Alaska Maritime NWR in both Homer and Adak—field camps would accomplish very little without their support. Finally, we would like to thank the crew of the M/V *Tiglax* for safe transport to and from the island.

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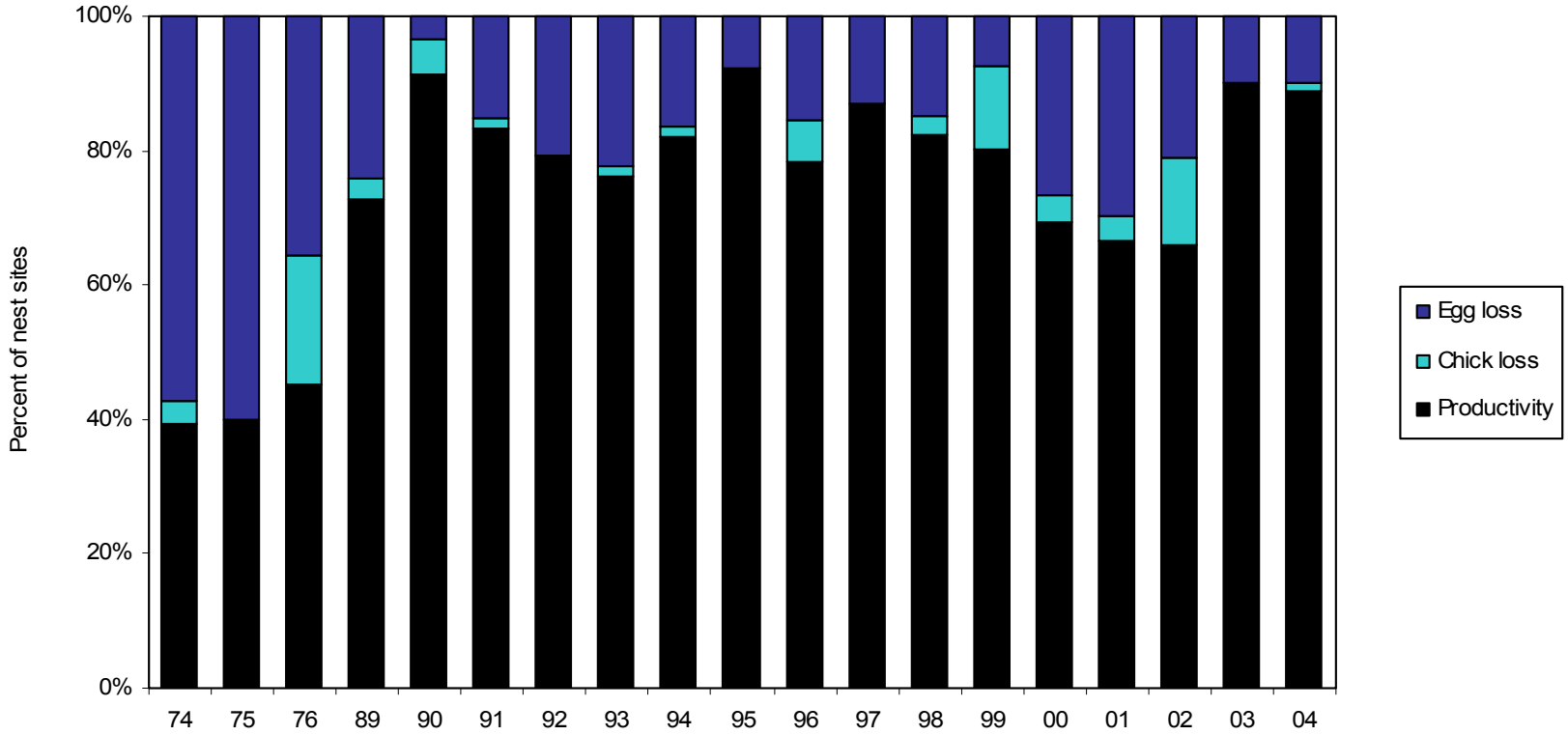

Figure 1. Reproductive performance of Leach's storm-petrels at Buldir Island, Alaska. These values represent the maximal reproductive potential. Actual values were undoubtedly lower. Egg loss=(C-D)/C; Chick loss=(D-E)/C; Productivity=E/C, where C=number of eggs, D=number of eggs hatched, E=number of chicks fledged or still alive at last check.

Table 1. Productivity and burrow occupancy rates of Leach's storm-petrels at Buldir Island, Alaska.

Parameter	1974	1975	1976	1989	1990	1991	1992	1993	1994	1995
Burrows with known contents (A)	69	71	113	232	285	287	294	249	297	280
Occupied burrows (B)	28	20	31	85	75	82	87	74	72	78
Eggs with known fate (C)	28	20	31	66	57	66	48	63	61	64
Eggs lost to disappearance	-	-	-	10	10	1	10	10	14	10
Eggs lost to abandonment	-	-	-	3	3	1	0	0	0	0
Eggs lost to breakage	-	-	-	3	3	0	0	0	0	0
Eggs remaining at last visit (unknown fate)[a]	-	-	-	18	18	18	16	39	11	11
Chicks (D)	12	8	20	50	50	55	56	38	49	51
Chicks lost to disappearance[b]	-	-	0	0	0	3	0	0	0	0
Chicks lost to death	-	-	6	2	2	2	1	0	1	1
Chicks potentially successful (E)	11	8	14	48	48	52	55	38	48	50
Chicks disappeared at unknown age or >55d	-	-	0	0	0	0	0	0	1	0
Chicks still present at last visit	11	8	14	48	48	52	55	38	47	50
Occupancy rate (B/A)	0.41	0.28	0.27	0.37	0.26	0.29	0.30	0.30	0.24	0.28
Hatching success (D/C)	0.43	0.40	0.65	0.72	0.96	0.85	0.79	0.78	0.82	0.92
Fledging success (E/D)[c]	0.92	1.00	0.70	0.96	0.95	0.98	1.00	0.98	0.98	1.00
Reproductive success (E/C)[c]	0.39	0.40	0.45	0.68	0.91	0.83	0.79	0.76	0.82	0.92

[a] Eggs still present, apparently viable, regardless of age not included in analysis.
[b] Chicks known to be <55 d when they disappeared or ones that disappeared before 1 Aug (earliest date we expected fledging).
[c] This value represents the maximum reproductive potential. Actual values were undoubtedly lower.

Table 1 continued. Productivity and burrow occupancy rates of Leach's storm-petrels at Buldir Island, Alaska.

Parameter	1996	1997	1998	1999	2000	2001	2002	2003	2004
Burrows with known contents (A)	308	277	282	265	304	189	285	116	283
Occupied burrows (B)	89	90	52	91	75	56	85	45	93
Eggs with known fate (C)	78	77	40	66	75	54	85	40	81
Eggs lost to disappearance	12	6	2	1	7	14	7	2	6
Eggs lost to abandonment	0	2	1	4	4	0	9	0	0
Eggs lost to breakage	0	2	0	0	2	2	0	2	2
Eggs remaining at last visit (unknown fate)[a]	10	7	14	17	7	1	2	0	4
Chicks (D)	66	67	34	61	55	38	67	36	73
Chicks lost to disappearance[b]	4	0	0	2	3	2	8	0	1
Chicks lost to death	1	0	1	6	0	0	3	0	0
Chicks potentially successful (E)	61	67	33	53	52	36	56	36	72
Chicks disappeared at unknown age or >55d	0	0	0	0	0	0	0	0	0
Chicks still present at last visit	61	67	30	53	52	36	56	36	72
Occupancy rate (B/A)	0.29	0.32	0.18	0.34	0.25	0.30	0.30	0.39	0.33
Hatching success (D/C)	0.85	0.87	0.85	0.92	0.73	0.70	0.79	0.90	0.90
Fledging success (E/D)[c]	0.92	1.00	0.97	0.87	0.95	0.95	0.84	1.00	0.99
Reproductive success (E/C)[c]	0.78	0.87	0.83	0.80	0.69	0.67	0.66	0.90	0.89

[a] Eggs still present, apparently viable, regardless of age not included in analysis.
[b] Chicks known to be <55 d when they disappeared or ones that disappeared before 1 Aug (earliest date we expected fledging).
[c] This value represents the maximum reproductive potential. Actual values were undoubtedly lower.

Table 2. Productivity and burrow occupancy rates of Leach's storm-petrels at Buldir Island, Alaska, 2004.

	Plot							
Parameter	1	2	3	4	7	8	All Plots	SD
Burrows with known contents (A)	26	45	28	41	65	78	283	
Occupied burrows (B)	5	23	5	11	27	22	93	
Eggs with known fate (C)	5	20	4	10	23	19	81	
Eggs lost to disappearance	2	0	0	0	3	1	6	
Eggs lost to abandonment	0	0	0	0	0	0	0	
Eggs lost to breakage	0	1	0	0	0	1	2	
Eggs remaining at last visit (unknown fate)	0	2	1	1	0	0	4	
Chicks (D)	3	19	4	10	20	17	73	
Chicks lost to disappearance[b]	0	1	0	0	0	0	1	
Chicks lost to death	0	0	0	0	0	0	0	
Chicks potentially successful (E)	3	18	4	10	20	17	72	
Chicks disappeared at unknown age or >55d	0	0	0	0	0	0	0	
Chicks still present at last visit	3	18	4	10	20	17	72	
Occupancy rate (B/A)	0.19	0.51	0.18	0.27	0.42	0.28	0.33	0.05
Hatching success (D/C)	0.60	0.95	1.00	1.00	0.87	0.89	0.90	0.03
Fledging success (E/D)[c]	1.00	0.95	1.00	1.00	1.00	1.00	0.99	0.01
Reproductive success (E/C)[c]	0.60	0.90	1.00	1.00	0.87	0.89	0.89	0.03

[b] Chicks known to be <55 d when they disappeared or ones that disappeared before 1 Aug (earliest date we expected fledging).
[c] This value represents the maximum reproductive potential. Actual values were undoubtedly lower.

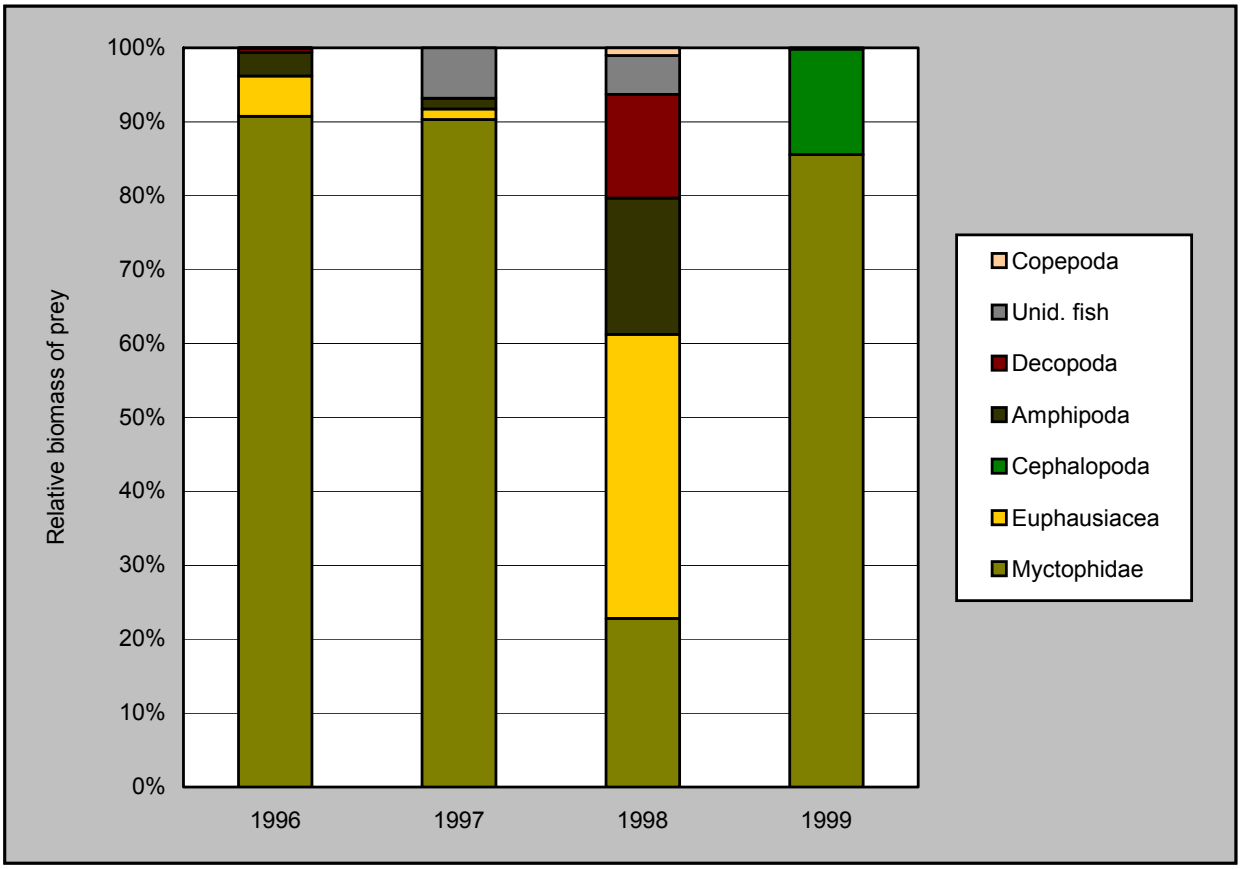

Figure 2. Relative biomass of prey in diets of Leach's storm-petrels at Buldir Island, Alaska.

Table 3. Relative biomass of prey in diets of Leach's storm-petrels at Buldir Island, Alaska. Numbers represent the percentage of the mass of combined food samples comprised by each species.

	1996	1997	1998	1999
No. samples	15	16	5	1
Total mass (g)	55.1	146.8	5.7	10.5
Cephalopoda				
Gonatidae				14.3
Copepoda				
Neocalanus cristatus	<0.1		1.1	
Amphipoda				
Unid Amphipod				0.2
Hyperiidea				
Hyperoche medusarum	0.2			
Parathemisto pacifica	0.1			
Gammaridea				
Lysianassidae	2.9	1.5	17.5	
Unid. Gammarid			0.9	
Euphausiacea				
Thysanoessa spp.	5.4	1.4		
Unid. Euphausiid			38.4	
Decapoda				
Shrimp zoea	<0.1			
Shrimp	0.5			
Crab zoea	<0.1			
Atelecyclidae megalopa			14.0	
Fish				
Myctophidae				
Stenobrachius leucopsarus		33.7	22.8	
Myctophid, not *S. leucopsarus*		15.7		
Unid. Myctophidae[a]	90.7	40.9		85.6
Unid. fish		6.8	5.3	

[a]Most, if not all, of the unidentified myctophids are probably *Stenobrachius leucopsarus*.

Table 4. Frequency of occurrence of prey in diets of Leach's storm-petrels at Buldir Island, Alaska. Frequency is expressed as the percentage of food samples in which each species was present.

	1996	1997	1998	1999
No. samples	15	16	5	1
Cephalopoda				
Gonatidae				100.0
Copepoda				
Neocalanus cristatus	6.7		20.0	
Amphipoda				
Unid. Amphipod				100.0
Hyperiidea				
Hyperoche medusarum	20.0			
Parathemisto pacifica	20.0			
Gammaridea				
Lysianassidae	20.0	43.8	60.0	
Euphausiacea				
Thysanoessa spp.	40.0	31.3		
Unid. Euphausiid			40.0	
Decapoda				
Shrimp zoea	6.7			
Shrimp	6.7			
Crab zoea	6.7			
Atelecyclidae megalopa			60.0	
Fish				
Myctophidae				
Stenobrachius leucopsarus		25.0	20.0	
Myctophid, not *S. leucopsarus*		6.3		
Unid. Myctophidae[a]	73.3	56.3		100.0
Unid. fish		6.3	20.0	

[a]Most, if not all, of the unidentified myctophids are probably *Stenobrachius leucopsarus*.

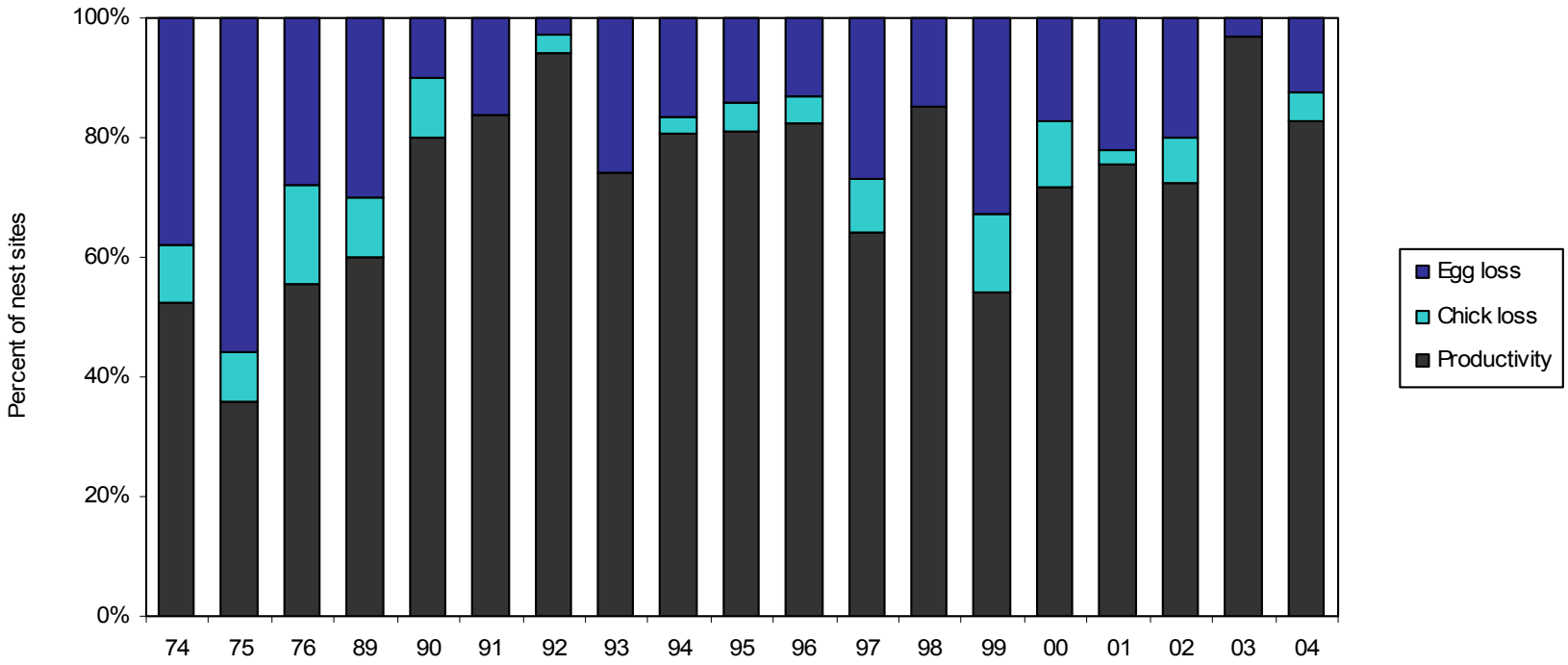

Figure 3. Reproductive performance of fork-tailed storm-petrels at Buldir Island, Alaska. These values represent the maximal reproductive potential. Actual values were undoubtedly lower. Egg loss=(C-D)/C; Chick loss=(D-E)/C; Productivity=E/C, where C=number of eggs, D=number of eggs hatched, E=number of chicks fledged or still alive at last check.

Table 5. Productivity and burrow occupancy rates of fork-tailed storm-petrels at Buldir Island, Alaska.

Parameter	1974	1975	1976	1989	1990	1991	1992	1993	1994	1995
Burrows with known contents (A)	69	71	113	232	285	287	294	249	297	280
Occupied burrows (B)	21	25	18	68	76	68	74	82	78	74
Eggs with known fate (C)	21	25	18	60	70	56	69	70	73	63
Eggs lost to disappearance	-	-	1	15	3	9	2	18	10	9
Eggs lost to abandonment	-	-	0	0	2	0	0	0	2	0
Eggs lost to breakage	-	-	4	3	2	0	0	0	0	0
Eggs remaining at last visit (unknown fate)[a]	-	-	-	7	4	11	4	11	5	11
Chicks (D)	13	11	13	42	63	47	67	52	61	54
Chicks lost to disappearance[b]	-	-	0	2	3	0	0	0	0	2
Chicks lost to death	-	-	3	4	4	0	2	0	2	1
Chicks potentially successful (E)	11	9	10	36	56	47	65	52	59	51
Chicks disappeared at unknown age or >55d	-	-	0	0	0	0	3	5	14	0
Chicks still present at last visit	11	9	10	36	56	47	62	47	45	51
Occupancy rate (B/A)	0.30	0.35	0.16	0.29	0.27	0.24	0.25	0.33	0.26	0.26
Hatching success (D/C)	0.62	0.44	0.72	0.70	0.90	0.84	0.97	0.74	0.84	0.86
Fledging success (E/D)[c]	0.85	0.82	0.77	0.86	0.89	1.00	0.97	1.00	0.97	0.94
Reproductive success (E/C)[c]	0.52	0.36	0.56	0.60	0.80	0.84	0.94	0.74	0.81	0.81

[a] Eggs still present, apparently viable, regardless of age not included in analysis.
[b] Chicks known to be <55 d when they disappeared or ones that disappeared before 1 Aug (earliest date we expected fledging).
[c] This value represents the maximum reproductive potential. Actual values were undoubtedly lower.

Table 5 continued. Productivity and burrow occupancy rates of fork-tailed storm-petrels at Buldir Island, Alaska.

Parameter	1996	1997	1998	1999	2000	2001	2002	2003	2004
Burrows with known contents (A)	308	277	282	265	304	189	285	116	283
Occupied burrows (B)	90	69	81	75	81	42	78	38	69
Eggs with known fate (C)	85	67	74	70	81	41	65	31	64
Eggs lost to disappearance	2	1	2	17	0	0	5	0	6
Eggs lost to abandonment	0	3	0	0	5	3	2	1	0
Eggs lost to breakage	9	14	9	6	8	5	6	0	2
Eggs remaining at last visit (unknown fate)[a]	5	2	4	1	1	0	0	0	0
Chicks (D)	74	49	63	47	67	32	52	30	56
Chicks lost to disappearance	3	1	0	5	7	1	3	0	0
Chicks lost to death	1	5	0	4	2	0	2	0	3
Chicks potentially successful (E)	70	43	63	38	58	31	47	30	53
Chicks disappeared at unknown age or >55d	65	42	58	38	48	31	40	20	9
Chicks still present at last visit	5	1	5	0	10	0	7	8	44
Occupancy rate (B/A)	0.29	0.25	0.21	0.28	0.27	0.22	0.27	0.33	0.24
Hatching success (D/C)	0.87	0.73	0.85	0.67	0.83	0.78	0.80	0.97	0.88
Fledging success (E/D)[c]	0.95	0.88	1.00	0.81	0.87	0.97	0.90	1.00	0.95
Reproductive success (E/C)[c]	0.83	0.64	0.85	0.54	0.72	0.76	0.72	0.97	0.69

[a] Eggs still present, apparently viable, regardless of age not included in analysis.
[b] Chicks known to be <55 d when they disappeared or ones that disappeared before 1 Aug (earliest date we expected fledging).
[c] This value represents the maximum reproductive potential. Actual values were undoubtedly lower.

Table 6. Productivity and burrow occupancy rates of fork-tailed storm-petrels at Buldir Island, Alaska, 2004.

	Plot							
Parameter	1	2	3	4	7	8	All Plots	SD
Burrows with known contents (A)	26	45	28	41	65	78	283	
Occupied burrows (B)	8	9	9	16	11	16	69	
Eggs with known fate (C)	8	9	8	16	9	14	64	
Eggs lost to disappearance	2	0	0	2	2	0	6	
Eggs lost to abandonment	0	0	0	0	0	0	0	
Eggs lost to breakage	0	0	2	0	0	0	2	
Eggs remaining at last visit (unknown fate)	0	0	0	0	0	0	0	
Chicks (D)	6	9	6	14	7	14	56	
Chicks lost to disappearance[a]	0	0	0	0	0	0	0	
Chicks lost to death	0	1	1	1	0	0	3	
Chicks potentially successful (E)	6	8	5	13	7	14	53	
Chicks disappeared at unknown age or >55d	0	1	2	2	0	4	9	
Chicks still present at last visit	6	7	3	11	7	10	44	
Occupancy rate (B/A)	0.31	0.20	0.32	0.39	0.17	0.21	0.24	0.03
Hatching success (D/C)	0.75	1.00	0.75	0.88	0.78	1.00	0.88	0.05
Fledging success (E/D)[b]	1.00	0.89	0.83	0.93	1.00	1.00	0.95	0.02
Reproductive success (E/C)[b]	0.75	0.89	0.63	0.81	0.78	1.00	0.83	0.05

[a] Chicks known to be <55 d when they disappeared or ones that disappeared before 1 Aug (earliest date we expected fledging).
[b] This value represents the maximum reproductive potential. Actual values were undoubtedly lower.

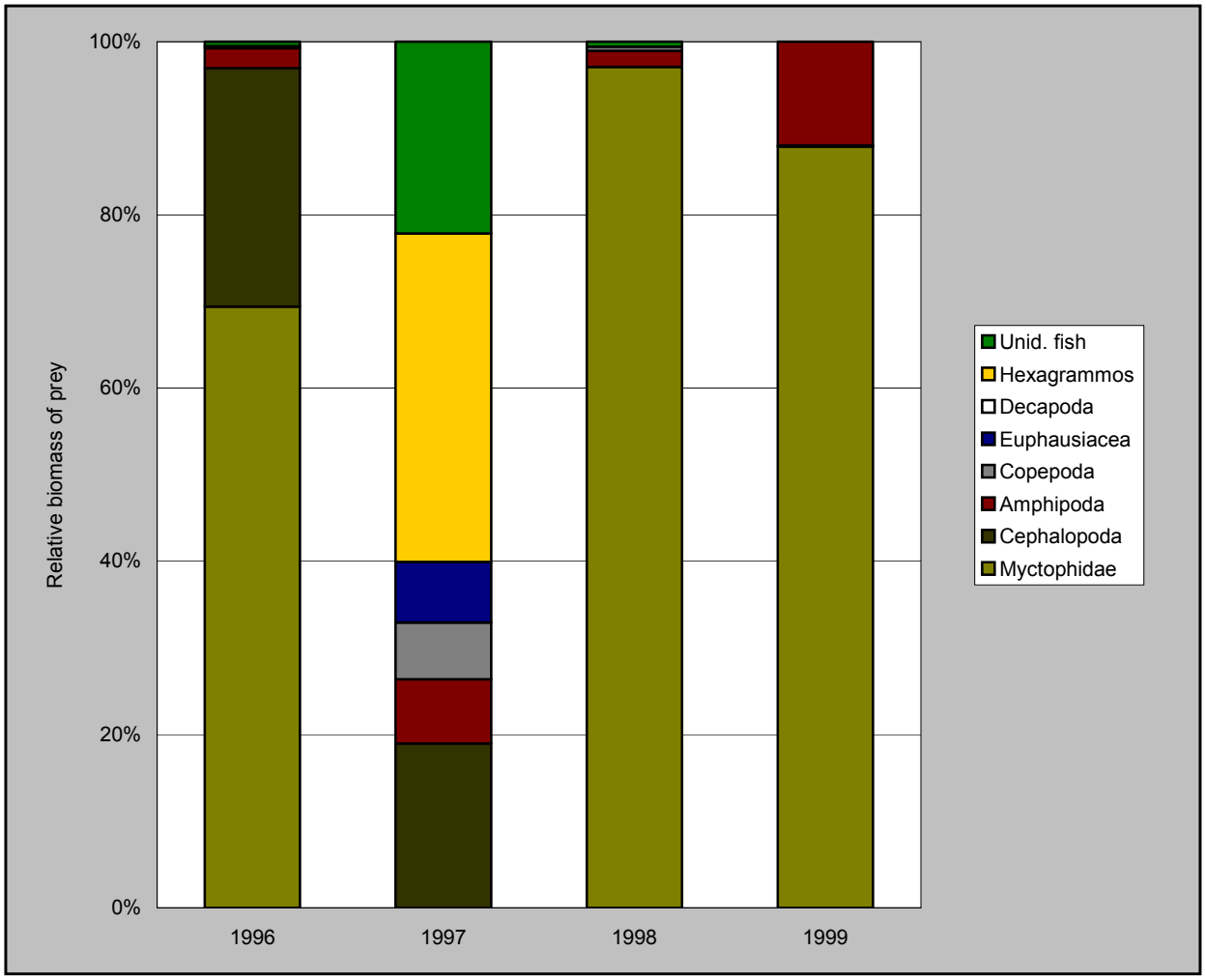

Figure 4. Relative biomass of prey in diets of fork-tailed storm-petrels at Buldir Island, Alaska.

Table 7. Relative biomass of prey in diets of fork-tailed storm-petrels at Buldir Island, Alaska. Numbers represent the percentage of the mass of combined food samples comprised by each species.

	1996	1997	1998	1999
No. samples	13	7	6	2
Total mass (g)	101.7	24.8	53.2	15.0
Cephalopoda - squid	27.5	12.1		0.1
Copepoda				
Neocalanus plumchrus	0.2	4.2	0.5	
Amphipoda				
Unid. Amphipod				12.0
Hyperiidea				
Hyperoche medusarum	<0.1			
Parathemisto pacifica	0.1			
Gammaridea				
Lysianassidae	2.3	4.7	1.9	
Euphausiacea				
Thysanoessa spp.		4.4		
Decapoda				
Shrimp zoea	<0.1			
Fish				
Myctophidae				
Stenobrachius leucopsarus		8.1	97.1	
Unid. Myctophidae[a]	69.4	28.2		87.9
Hexagrammos spp.		24.2		
Unid. fish	0.5	14.1	0.6	

[a]Most, if not all, of the unidentified myctophids are probably *Stenobrachius leucopsarus*.

Table 8. Frequency of occurrence of prey in diets of fork-tailed storm-petrels at Buldir Island, Alaska. Frequency is expressed as the percentage of food samples in which each species was present.

	1996	1997	1998	1999
No. samples	13	7	6	2
Cephalopoda - squid	53.8	28.6		50.0
Copepoda				
Neocalanus plumchrus	15.4	28.6	16.7	
Amphipoda				
Unid. Amphipod				50.0
Hyperiidea				
Hyperoche medusarum	7.7			
Parathemisto pacifica	15.4			
Gammaridea				
Lysianassidae	46.2	57.1	50.0	
Euphausiacea				
Thysanoessa spp.		14.3		
Decapoda				
Shrimp zoea	7.7			
Unid. Crustacea		14.3		
Fish				
Myctophidae				
Stenobrachius leucopsarus		14.3	100.0	
Unid. Myctophidae[a]	76.9	42.9		100.0
Hexagrammos spp.		14.3		
Unid. fish	7.7	28.6		
(Plastic - not prey)		14.3	33.3	

[a]Most, if not all, of the unidentified myctophids are probably *Stenobrachius leucopsarus*.

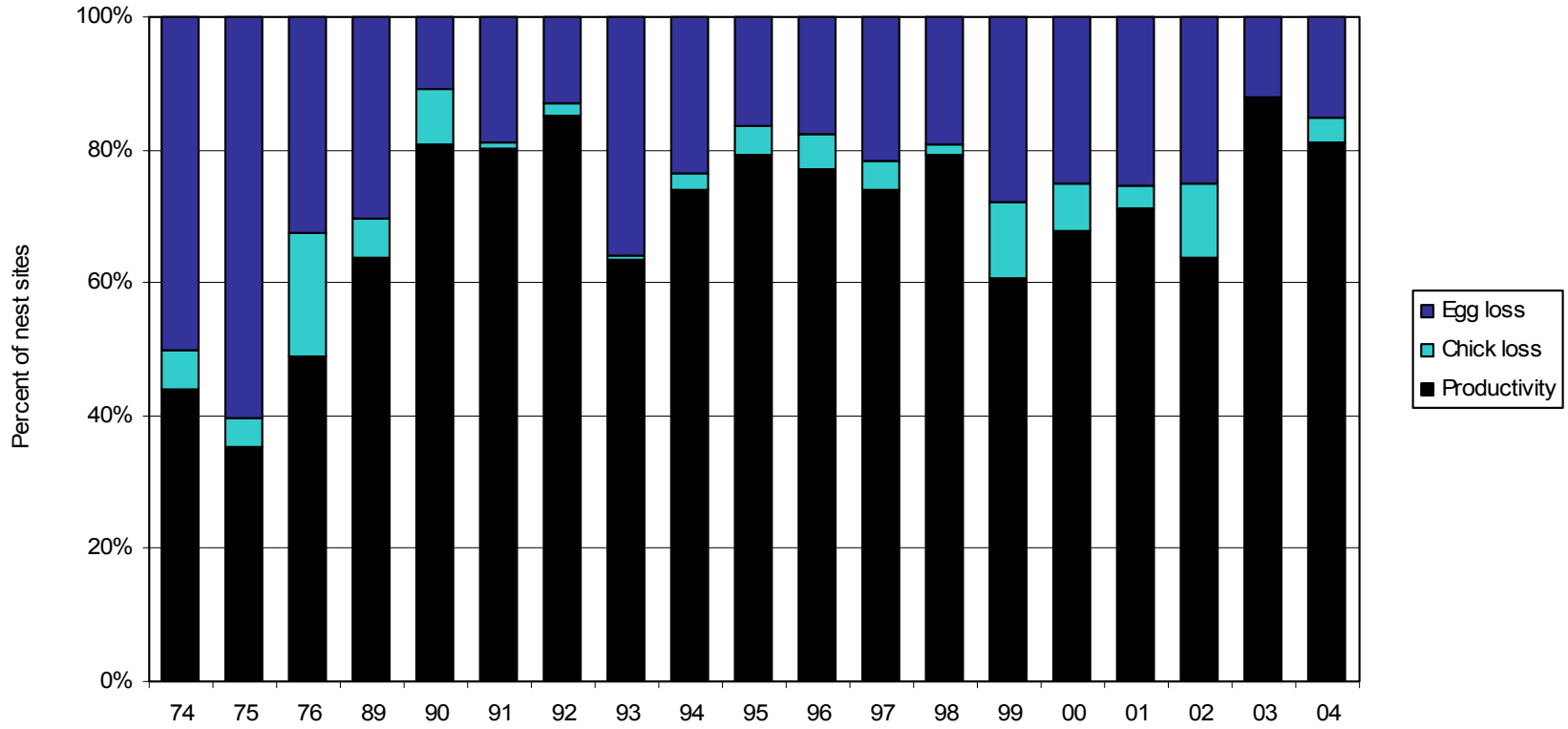

Figure 5. Reproductive performance of storm-petrels (Leach's, fork-tailed and unknown species) at Buldir Island, Alaska. These values represent the maximal reproductive potential. Actual values were undoubtedly lower. Egg loss=(C-D)/C; Chick loss=(D-E)/C; Productivity=E/C, where C=number of eggs, D=number of eggs hatched, E=number of chicks fledged or still alive at last check.

Table 9. Productivity and burrow occupancy rates of storm-petrels (Leach's, fork-tailed, and unknown spp.) at Buldir Island, Alaska.

Parameter	1974	1975	1976	1989	1990	1991	1992	1993	1994	1995
Burrows with known contents (A)	69	71	113	232	285	287	294	249	297	280
Occupied burrows (B)	50	48	49	160	181	163	180	170	183	168
Eggs with known fate (C)	50	48	49	132	146	132	122	162	166	139
Eggs lost to disappearance	-	-	28	10	25	16	37	27	18	28
Eggs lost to abandonment	-	-	26	29	30	57	27	17	28	26
Eggs lost to breakage	-	-	5	2	0	0	0	12	5	5
Eggs remaining at last visit (unknown fate)[a]	-	-	7	4	0	0	1	0	0	7
Chicks (D)	25	19	33	92	130	107	106	104	127	116
Chicks lost to disappearance[b]	-	-	0	2	6	0	0	0	0	4
Chicks lost to death	-	-	9	6	8	1	2	1	4	2
Chicks potentially successful (E)	22	17	0	0	1	0	3	6	22	0
Chicks disappeared at unknown age or >55d	-	-	24	84	118	106	104	103	123	110
Chicks still present at last visit	22	17	24	84	117	106	101	97	101	110
Occupancy rate (B/A)	0.72	0.68	0.43	0.69	0.64	0.57	0.61	0.68	0.62	0.60
Hatching success (D/C)	.50	0.40	0.67	0.70	0.89	0.81	0.87	0.64	0.77	0.83
Fledging success (E/D)[c]	0.88	0.89	0.73	0.91	0.91	0.99	0.98	0.99	0.97	0.95
Reproductive success (E/C)[c]	0.44	0.35	0.49	0.64	0.81	0.80	0.85	0.64	0.74	0.79

[a] Eggs still present, apparently viable, regardless of age not included in analysis.
[b] Chicks known to be <55 d when they disappeared or ones that disappeared before 1 Aug (earliest date we expected fledging).
[c] This value represents the maximum reproductive potential. Actual values were undoubtedly lower.

Table 9 continued. Productivity and burrow occupancy rates of storm-petrels (Leach's, fork-tailed, and unknown spp.) at Buldir Island, Alaska.

Parameter	1996	1997	1998	1999	2000	2001	2002	2003	2004
Burrows with known contents (A)	308	277	282	265	304	189	285	116	283
Occupied burrows (B)	190	168	149	182	164	103	191	94	185
Eggs with known fate (C)	170	153	125	150	164	94	179	75	158
Eggs lost to disappearance	26	25	14	11	18	19	19	3	15
Eggs lost to abandonment	4	3	10	31	5	0	19	1	0
Eggs lost to breakage	0	5	0	0	10	5	4	5	9
Eggs remaining at last visit (unknown fate)[a]	17	9	20	16	8	1	3	0	5
Chicks (D)	140	120	101	108	123	70	134	66	134
Chicks lost to disappearance[b]	7	1	0	7	10	3	12	0	1
Chicks lost to death	2	6	2	13	2	0	8	0	5
Chicks potentially successful (E)	126	111	91	91	101	67	107	58	128
Chicks disappeared at unknown age or >55d	5	2	5	0	10	0	7	8	9
Chicks still present at last visit	131	113	99	91	111	67	114	66	119
Occupancy rate (B/A)	0.62	0.61	0.53	0.69	0.54	0.54	0.67	0.81	0.65
Hatching success (D/C)	0.82	0.78	0.81	0.72	0.75	0.75	0.75	0.88	0.85
Fledging success (E/D)[c]	0.77	0.74	0.79	0.61	0.68	0.71	0.64	0.88	0.96
Reproductive success (E/C)[c]	0.94	0.94	0.98	0.84	0.90	0.96	0.85	1.00	0.81

[a] Eggs still present, apparently viable, regardless of age not included in analysis.
[b] Chicks known to be <55 d when they disappeared or ones that disappeared before 1 Aug (earliest date we expected fledging).
[c] This value represents the maximum reproductive potential. Actual values were undoubtedly lower.

Table 10. Productivity and burrow occupancy rates of fork-tailed and Leach's storm-petrels (incl. unknown spp.) at Buldir Island, Alaska, 2004.

	Plot							
Parameter	1	2	3	4	7	8	All Plots	SD
Burrows with known contents (A)	26	45	28	41	65	78	283	
Occupied burrows (B)	14	40	16	30	41	44	185	
Eggs with known fate (C)	13	36	13	26	34	36	158	
Eggs lost to disappearance	4	1	1	2	5	2	15	
Eggs lost to abandonment	0	0	0	0	0	0	0	
Eggs lost to breakage	0	4	2	0	2	1	9	
Eggs remaining at last visit (unknown fate)[a]	0	2	1	1	0	1	5	
Chicks (D)	9	31	10	24	27	33	134	
Chicks lost to disappearance[b]	0	1	0	0	0	0	1	
Chicks lost to death	0	2	1	1	0	1	5	
Chicks potentially successful (E)	9	28	9	23	27	32	128	
Chicks disappeared at unknown age or >55d	0	1	2	2	0	4	9	
Chicks still present at last visit	9	27	7	21	27	28	119	
Occupancy rate (B/A)	0.54	0.89	0.57	0.73	0.63	0.56	0.65	0.05
Hatching success (D/C)	0.69	0.86	0.77	0.92	0.79	0.92	0.85	0.03
Fledging success (E/D)[c]	1.00	0.90	0.90	0.96	1.00	0.97	0.96	0.02
Reproductive success (E/C)[c]	0.69	0.78	0.69	0.89	0.79	0.89	0.81	0.03

[a] Eggs still present, apparently viable, regardless of age not included in analysis
[b] Chicks known to be <55 d when they disappeared or ones that disappeared before 1 Aug (earliest date we expected fledging).
[c] This value represents the maximum reproductive potential. Actual values were undoubtedly lower.

Table 11. Pelagic cormorant productivity at Buldir Island, Alaska in early to mid-August.

Parameter		1974[a]	1989	1990	1992	1993	1994	1995	1996
Total number of nests (A)		53	37	34	35	21	28	14	17
Date of maximum nest count		5 Jun	16 Jun	13 Aug	11 Jun	12 Jun	15 Jun	13 Jun	1 Aug
Total number of chicks (B)		23	-	61	25	13	36	17	13
Date of maximum chick count		19 Aug	-	13 Aug	2 Aug	19 Aug	9 Aug	10 Aug	5 Aug
Number of large chicks in nest:	0	-	-	7	25	14	10	5	9
	1	-	-	4	0	3	6	3	3
	2	-	-	12	5	2	6	4	5
	3	-	-	11	5	2	6	2	0
Number of nests with chicks (C)		-	-	27	10	7	18	9	8
Mean brood size (B/C)		-	-	2.3	2.5	1.9	2.0	1.9	1.6
SD		-	-	0.7	0.5	0.9	0.8	0.8	0.5
% of nests w/ chicks ((C/A)X100)		68.8[b]	-	79.4	28.6	33.3	64.3	64.3	47.1
Productivity[c] (B/A)		1.4[b]	-	1.8	0.9	0.6	1.3	1.2	0.8

[a] Nest contents were not recorded in 1974 or 1989. Data from 1974 from Byrd (1978). In all years, observers counted cormorant nests along 2 transects each year: Main Talus to Petrel Valley, and Petrel Valley to East Gull Slide.
[b] From a subsample of 16 nests.
[c] Number of chicks present per nest, including empty nests.

Table 11 continued. Pelagic cormorant productivity at Buldir Island, Alaska.

Parameter		1997	1998	1999	2000	2001	2002	2003	2004
Total number of nests (A)		22	29	24	48	64	66	73	79
Date of maximum nest count		25 May	22 Jun	24 Jun	6 June	10 Jun	16 Jun	13 Jun	27 Jun
Total number of chicks (B)		24	18	31	52	55	59	39	72
Date of maximum chick count		10 Aug	7 Aug	12 Aug	4 Aug	29 Jul	5 Aug	1 Aug	3 Aug
Number of chicks in nest[a]:	0	13	14	7	3	18	0	26	17
	1	0	0	2	8	9	9	8	2
	2	3	6	8	10	18	19	11	15
	3	6	2	5	0	3	4	3	12
	4	0	0	0	0	0	0	0	1
Number of nests with chicks (C)		9	8	15	25	33	32	22	30
Mean brood size (B/C)		2.7	2.3	2.2	2.1	1.8	1.8	1.7	2.4
SD		0.5	0.5	0.7	0.9	0.6	0.6	0.7	0.7
% of nests w/ chicks ((C/A)X100)		40.9	27.6	62.5	52.1	51.6	48.5	45.2	40.0
Productivity[b] (B/A)		1.1	0.6	1.3	1.1	0.9	0.9	0.5	0.9

[a] On date of maximum chick count
[b] Number of chicks present per nest, including empty nests.

Table 12. Red-faced cormorant productivity at Buldir Island, Alaska.

Parameter		2003	2004
Total number of nests (A)		4	9
Date of maximum nest count		19 Jun	17 Jun
Total number of chicks (B)		5	11
Date of maximum chick count		25 Jun	3 Aug
Max. count of large chicks in nest[a]:	0	1	2
	1	1	1
	2	2	2
	3	0	2
Number of nests with chicks (C)		3	5
Mean brood size (B/C)		1.67	2.2
SD		0.60	0.8
% of nests with chicks ((C/AX100))		75.0	55.6
Productivity[b] (B/A)		1.25	1.22

[a] On date of maximum chick count
[b] Number of chicks present per nest, including empty nests.

Table 13. Pelagic cormorant productivity at Buldir Island, Alaska in 2004.

		No. nests containing *X* chicks					No. nests	
Date	No. nests	0	1+	2+	3+	4+	w/ chick	no. chicks
2 Jul	73	73	0	0	0	0	0	0
18 Jul	59	42	4	13	0	0	17	30
23 Jul	54	35	5	9	5	0	19	38
29 Jul	45	16	9	9	10	1	29	61
3 Aug	47	17	2	15	12	1	30	72
7 Aug	44	16	9	12	6	1	28	55
12 Aug	46	19	12	11	4	0	27	46
17 Aug	45	18	10	14	3	0	27	47

Table 14. Red-faced cormorant productivity at Buldir Island, Alaska in 2004.

		No. nests containing *X* chicks					No. nests	
Date	No. nests	0	1+	2+	3+	4+	w/ chick	no. chicks
2 Jul	8	8	0	0	0	0	0	0
18 Jul	6	4	1	1	0	0	2	3
23 Jul	8	5	1	1	1	0	3	6
29 Jul	8	3	1	3	1	0	5	10
3 Aug	7	2	1	2	2	0	5	11
17 Aug[a]	7	2	3	1	1	0	5	8

[a] RFCO checks on 7 and 12 August were obscured by fog and no data were collected.

Table 15. Glaucous-winged gull productivity at Buldir Island, Alaska. Measures of success are based on eggs as the sample unit.

Parameter	1979[a]	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total no. nests (A)	--	209	199	180	133	175	88	75	20	54	--	38	23	31
No. eggs in nest:														
0	0	49	66	49	82	40	63	18	17	11	--	9	0	5
1	1	28	26	15	5	15	6	8	0	3	--	2	2	3
2	10	48	35	40	20	35	10	26	2	10	--	4	1	4
3	56	84	72	75	26	85	9	22	1	30	--	23	13	15
4	0	0	0	1	0	0	0	0	0	0	--	0	0	0
Clutch size: $\tilde{}$ mean:	2.82	2.35	2.35	2.47	2.41	2.52	2.12	2.25	2.3	2.8	--	2.7	2.69	2.55
n (B)	67	160	133	131	51	135	25	56	3	43	--	29	16	16
SD	0.42	0.76	0.79	0.70	0.67	0.67	0.78	0.69	0.58	0.43	--	0.59	0.70	0.74
Max. no. eggs (C)[b]	--	376	312	324	123	340	53	126	7	113	--	81	53	69
Maximum no. chicks seen (D)	--	122	35	49	34	83	28	28	2	17	--	33	22	23
Chicks seen on last visit before fledging (E)	--	89	8	48	14	34	15	9	0	12	--	15	19	22
Laying success (B/A)	--	0.77	0.67	0.73	0.38	0.77	0.28	0.75	0.15	0.80	--	0.76	0.70	0.52
Hatch success (D/C)	--	0.32	0.11	0.15	0.28	0.24	0.53	0.22	0.29	0.15	--	0.41	0.42	0.33
Fledge success (E/D)	--	0.73	0.23	0.98	0.41	0.41	0.54	0.32	0.00	0.71	--	0.45	0.86	0.07
Breeding success (E/C)	--	0.24	0.03	0.15	0.11	0.10	0.28	0.07	0.00	0.11	--	0.19	0.36	0.31
Overall prod (E/A)	--	0.43	0.04	0.27	0.11	0.19	0.17	0.12	0.00	0.22	--	0.39	0.83	0.71

[a] Data for 1979 were collected at plots located in the interior of Buldir (Day et al. 1980) and are comparable only for estimates of clutch size with other years.
[b] Observers counted glaucous-winged gulls from E. Main Talus to East Kittiwake Lane.

Table 16. Glaucous-winged gull productivity at Buldir Island, Alaska. Measures of success are based on nests as the sample unit.

Parameter	1997	1998	1999	2000	2001	2002	2003	2004
No. nests (A)	47	30	20	28	--	37	23	34
No. nests w/ ≥ 1 egg (B)	10	26	3	24	--	31	22	27
No. eggs (C)	22	58	7	63	--	89	56	78
No. nests ≥ 1 chick (D)	8	13	1	10	--	26	20	18
No. chicks (E)	14	21	2	18	--	57	38	38
Laying success (B/A)	0.21	0.87	0.15	0.86	--	0.84	0.96	0.79
Nesting success (D/B)	0.80	0.50	33.3	0.42	--	0.84	0.91	0.67
Hatching success (E/C)	0.64	0.36	0.29	0.29	--	0.64	0.68	0.49
Mean hatch date	11 July	2 July	23 Jun	23 Jun	--	21 Jun	--[a]	15 Jun
n	5	13	1	7	--	14	--	18
SD	2.2	3.4	--	6.2	--	6.4	--	7.4

[a] Hatch dates not calculated; chicks were present on the first visit.

Table 17. Clutch size of glaucous-winged gulls at Buldir Island, Alaska in 2004.

Date	No. nests	No. nests containing *X* eggs				Total No. eggs	No. chicks
		0	1	2	3		
2 Jun	29	6	3	11	40	69	0
5 Jun	30	3	1	5	21	30	0
12 Jun	31	5	3	4	15	56	11
17 Jun	31	10	2	1	10	34	23
22 Jun	23	6	1	1	5	18	21
27 Jun	25	12	0	1	3	11	16
2 Jul	--	7	0	1	0	2	--
18 Jul[a]	--	--	--	--	--	--	13
23 Jul[a]	--	--	--	--	--	--	22

[a] Due to chick mobility, chicks counted by section rather than by individual nests.

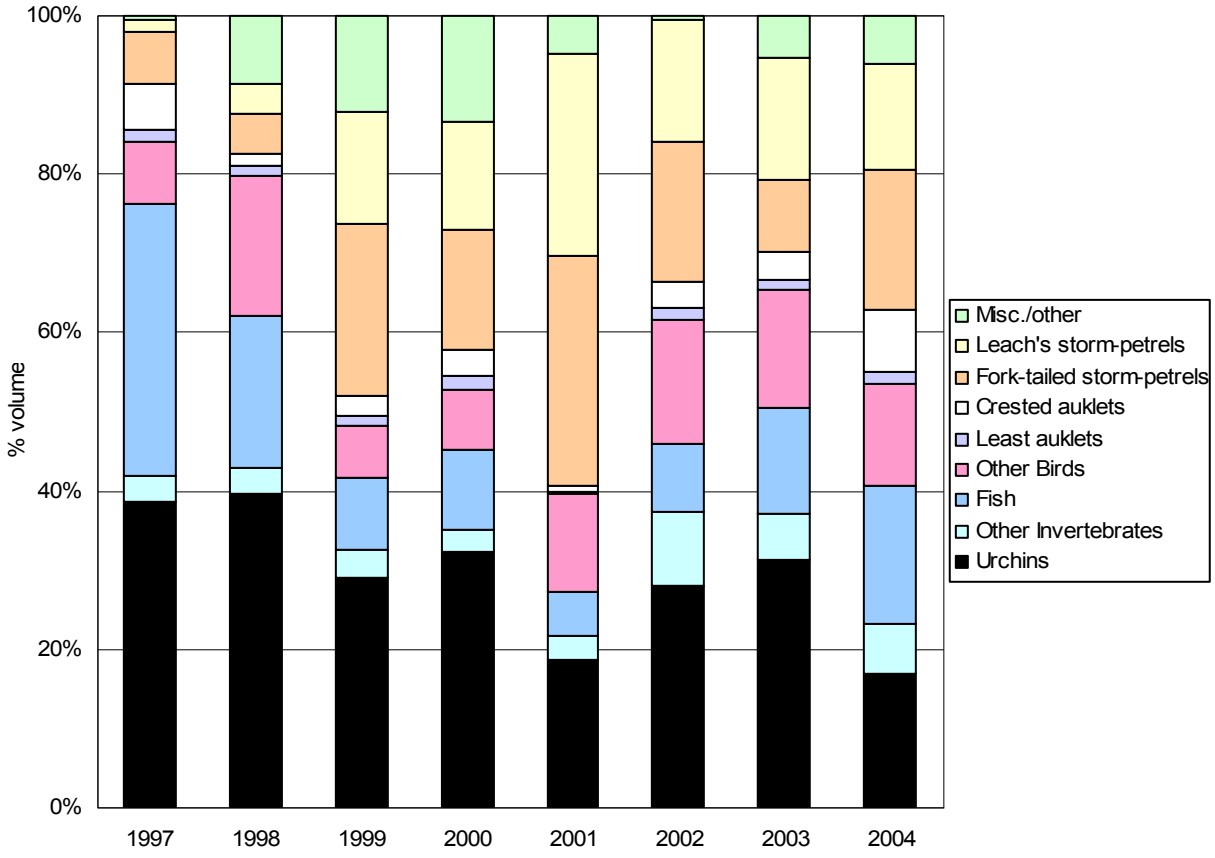

Figure 6. Percent volume of food items in regurgitated pellets of glaucous-winged gulls at Buldir Island, Alaska. Composite value for Invertebrates does not include Urchins. Composite value for Birds is inclusive of all species except crested auklet, least auklet, fork-tailed storm-petrel, and Leach's storm-petrel.

Table 18. Occurrence of food items (%) in regurgitated pellets of glaucous-winged gulls along the north shore of Buldir Island, Alaska in various years.

Food item sample size	1974-76[a] 655	1997 158	1998 210	1999 505	2000 279	2001 281	2002 247	2003 660	2004 301
Invertebrates[b]	**1.9**	**46.2**	**49.5**	**38.4**	**42.3**	**28.1**	**46.6**	**47.4**	**31.2**
sea urchin	1.1	39.9	42.8	33.5	37.3	22.4	31.6	35.9	22.3
blue mussel	--	3.2	2.4	2.4	2.9	2.1	3.2	2.4	3.7
snail	--	0.6	1.0	0.2	1.1	0.4	4.0	0.5	--
limpet	--	1.3	--	1.0	0.4	1.8	4.5	6.7	1.3
chiton	--	--	1.9	0.2	0.4	--	0.8	--	3.7
crab	--	0.6	0.5	0.2	0.4	0.4	--	0.3	--
unid. bivalve	--	0.6	0.5	0.4	--	0.7	--	--	0.3
unid. shellfish	--	--	--	0.2	--	0.4	1.2	1.7	--
amphipod	--	--	--	0.2	--	--	0.4	--	--
beetle	--	--	--	0.2	--	--	--	--	--
unid. kelp fly	0.08	--	--	--	--	--	--	--	--
Euphausiid	--	--	--	--	--	--	0.8	--	--
Fish	**19.5**	**36.1**	**21.4**	**11.3**	**12.2**	**6.4**	**13.8**	**18.3**	**25.2**
<10 cm	--	8.9	10.0	6.5	2.5	1.8	6.1	12.1	9.3
10-20 cm	--	12.0	9.5	4.2	6.1	3.9	6.1	0.2	14.6
>20 cm	--	15.2	1.9	0.6	3.6	0.7	1.6	1.5	0.3
unknown size	--	--	--	--	--	--	--	4.5	0.7
Birds	**79.2**	**24.1**	**31.9**	**48.5**	**44.8**	**70.1**	**60.7**	**48.9**	**59.5**
crested auklet	2.9	6.3	1.0	2.4	3.6	0.7	4.0	3.8	8.6
least auklet	1.4	1.3	1.4	1.4	1.8	0.4	1.6	1.2	1.7
whiskered auklet	--	--	--	0.2	0.4	0.4	--	--	--
parakeet auklet	--	--	0.5	0.2	2.5	1.1	1.6	2.7	0.7
Cassin's auklet	0.2	--	0.5	--	0.4	--	--	0.9	--
ancient murrelet	10.1	--	0.5	0.2	2.9	14.3	6.9	2.0	1.0
unid. sm. Auklet	--	1.3	--	--	0.7	--	--	0.2	--
unid med. Auklet	--	1.3	--	0.4	--	--	--	--	0.7
unid. auklet	1.4	3.8	0.5	0.4	0.7	0.7	3.6	--	1.0
fork-tailed storm-petrel	40.0	7.0	5.7	22.2	16.1	29.5	18.2	9.1	18.6
Leach's storm-petrel	20.0	1.3	3.8	15.4	14.3	26.3	16.2	16.1	14.3
unid. storm-petrel	0.8	1.9	4.8	2.2	--	--	2.0	1.5	--
black-legged kittiwake	0.2	--	--	--	--	--	0.4	--	--
unid. kittiwake	--	--	--	--	--	--	--	1.2	7.6
murre chick	--	--	--	--	--	--	--	--	0.3
tufted puffin	0.2	--	--	--	--	--	0.8	--	--
unid. puffin	--	--	--	--	--	--	--	0.2	--
Aleutian Cackling gosling	--	--	--	0.2	0.4	--	0.8	--	--
Aleutian Cackling eggs	--	--	--	--	--	--	--	1.2	--
unid. sm. bird	0.3	0.6	13.3	1.4	1.1	5.3	0.8	6.4	1.0
unid. bird eggs	1.7	--	--	2.0	--	1.4	4.0	1.2	4.0
glaucous-winged gull	--	--	--	--	--	0.4	--	--	--
gull eggs	--	--	--	--	--	--	--	1.4	--
Miscellaneous	**6.8**	**1.3**	**10.0**	**18.0**	**21.5**	**1.4**	**1.6**	**8.3**	**15.9**
terrestrial vegetation	2.5	--	--	0.4	2.2	--	--	0.5	0.3
unid. marine algae	--	1.3	5.7	15.8	15.1	3.9	2.0	7.4	13.0
pebbles	0.8	--	4.3	1.8	1.4	1.9	0.8	0.3	2.3
sea lion hair	3.5	--	--	--	--	--	--	--	--
plastic	--	--	--	--	2.9	--	2.0	0.2	0.3

[a] From Trapp 1979
[b] All values represent percent occurrence in total sample. Values in bold are composite totals for invertebrates, fish, birds, and miscellaneous.

Table 19. Percent volume of food in regurgitated pellets of glaucous-winged gulls along the north shore of Buldir Island, Alaska in various years.

Food item sample size	1997 158	1998 210	1999 505	2000 279	2001 281	2002 247	2003 660	2004 301
Invertebrates[a]	**42.0**	**42.9**	**32.6**	**35.1**	**21.7**	**37.3**	**37.1**	**23.1**
sea urchin	38.7	39.6	29.1	32.3	18.6	28.2	31.2	16.8
blue mussel	2.3	1.8	1.9	1.5	1.0	2.2	0.8	2.5
snail	<0.1	<0.1	0.2	1.1	<0.1	1.9	0.2	--
limpet	0.8	--	0.8	0.2	1.3	3.2	3.9	0.9
chiton	--	<0.1	0.2	0.1	--	0.6	--	2.9
crab	<0.1	<0.1	<0.1	<0.1	0.3	--	--	--
unid. bivalve	0.1	--	0.2	--	0.4	--	--	--
unid. shellfish	--	<0.1	<0.1	--	<0.1	0.4	0.9	--
amphipod	--	--	--	--	--	<0.1	--	--
beetle	--	--	<0.1	--	--	--	--	--
unid. kelp fly	--	--	--	--	--	--	--	--
euphausiid	--	--	--	--	--	0.8	--	--
Fish[b]	**34.3**	**19.3**	**9.0**	**10.0**	**5.6**	**8.8**	**13.3**	**17.5**
<10 cm	7.4	9.9	4.8	1.6	1.0	4.8	9.4	5.4
10-20 cm	11.7	5.1	3.8	5.2	3.9	3.4	0.1	11.5
>20 cm	15.2	4.3	0.4	3.2	0.7	0.6	1.3	0.3
unidentified	--	--	--	--	--	--	2.4	0.4
Birds	**23.1**	**29.2**	**46.2**	**41.5**	**67.9**	**53.6**	**44.4**	**53.1**
crested auklet	6.0	1.4	2.4	3.3	0.7	3.5	3.6	8.0
least auklet	1.3	1.4	1.4	1.8	0.4	1.4	1.2	1.4
whiskered auklet	--	--	0.2	0.4	0.4	--	--	--
parakeet auklet	--	0.5	0.2	2.5	1.1	1.4	2.6	0.7
Cassin's auklet	--	0.5	--	0.4	--	--	0.8	--
ancient murrelet	--	0.5	0.2	2.7	4.0	6.2	2.0	0.9
unid. sm. Auklet[c]	0.3	--	--	<0.1	--	--	--	--
unid med. Auklet[c]	0.6	--	0.4	--	--	--	--	0.6
unid. auklet	4.4	0.5	0.4	0.7	0.7	3.6	--	1.0
fork-tailed storm-petrel	6.7	5.2	21.7	15.1	29.0	17.5	9.0	17.4
Leach's storm-petrel	1.3	3.8	14.2	13.6	25.5	15.6	15.5	13.5
unid. storm-petrel	1.9	3.8	2.0	--	--	1.3	1.4	--
black-legged kittiwake	--	--	--	--	--	0.4	--	--
unidentified kittiwake	--	--	--	--	--	--	1.1	7.5
murre chick	--	--	--	--	--	--	--	0.3
tufted puffin	--	--	--	--	--	1.0	--	--
unidentified puffin	--	--	--	--	--	--	0.1	--
Aleutian Cackling gosling	--	--	0.2	0.4	--	0.5	--	--
glaucous-winged gull	--	--	--	--	<0.1	--	--	--
unid. sm. bird	0.6	11.0	1.3	0.7	5.0	0.1	4.3	0.4
gull egg	--	--	--	--	--	--	1.4	--
goose egg	--	--	--	--	--	--	1.0	--
unid. bird eggs	--	0.8	1.6	--	1.2	0.5	0.4	1.4
Miscellaneous	**0.6**	**8.5**	**12.0**	**13.4**	**4.9**	**0.4**	**5.2**	**5.9**
terrestrial vegetation	--	--	0.2	1.1	--	--	0.1	0.3
unid. marine algae	0.6	4.9	11.1	11.6	2.2	0.2	5.0	5.2
pebbles	--	3.6	0.7	0.6	2.7	<0.1	0.1	0.5
sea lion hair	--	--	--	--	--	--	--	--
plastic	--	--	--	0.2	--	0.1	--	--

[a] All values represent percent of the volume of all samples comprised by each item. Values in bold are composite totals for invertebrates, fish, birds, and miscellaneous

[b] Regurgitated fish masses were not identifiable to species.

[c] Some identifications to species were difficult because of the age or condition of the pellet or that insufficient materials for a complete identification were available. Unidentified small auklet means the specimen was believed to have been a Least or Whiskered Auklet. Unidentified medium auklet means the specimen was believed to have been a Parakeet or Crested Auklet.

Table 20. Occurrence of food items in 301 regurgitated pellets of glaucous-winged gulls along the north shore of Buldir Island, Alaska, 4 June-7 Aug 2004.

Food item	no. samples	min. no. birds/orgs.	% occurrence[a]
Invertebrates	**94**	**176**	**31.2**
sea urchin	67	67	22.3
blue mussel	11	15	3.7
snail	--	--	--
limpet	4	8	1.3
chiton	11	11	3.7
crab	--	--	--
unid. shellfish	--	--	--
unid. bivalve	1	8	0.3
Fish[b]	**76**	**89**	**25.2**
<10 cm	28	30	9.3
10-20 cm	44	44	14.6
>20 cm	1	1	0.3
unk. size	3	3	1.0
Birds	**179**	**182**	**59.5**
crested auklet	25	25	8.3
least auklet	5	5	1.7
parakeet auklet	2	2	0.7
cassin's auklet	--	--	--
unid. alcid	3	3	1.0
unid med. alcid	2	2	0.7
ancient murrelet	3	3	1.0
unid. kittiwake	24	24	7.6
murre chick	1	1	0.3
fork-tailed storm-petrel	56	58	18.6
Leach's storm-petrel	43	44	14.3
unid. sm. bird	3	3	1.0
unid. storm-petrel	--	--	--
unid. puffin	--	--	--
gull egg	--	--	--
goose egg	--	--	--
unid. egg	12	12	4.0
Miscellaneous	**48**	**123**	**15.9**
terr. plant material	1	1	0.3
kelp/sea weed	39	39	13.0
pebbles	7	82	2.3
plastic	1	1	0.3

[a] All values represent percent occurrence in total sample. Values in bold are composite totals for invertebrates, fish, birds, and miscellaneous. Summation of columns exceeds 100% because of overlap (i.e. occurrence of more than 1 prey species per pellet).

[b] Regurgitated fish masses were not identifiable to species without sending samples to a lab. Most fish were large and were possibly Atka mackerel or Pacific cod.

Table 21. Breeding chronology dates for black-legged kittiwakes at Buldir Island, Alaska.

Year	mean hatch	SD	n[a]	median hatch	no. nests monitored[b]	first lay	last lay	first hatch	last hatch	first fledge
1988	3 Jul	--	246	--	--	--	--	--	--	--
1989	16 Jul	--	52	--	--	--	--	--	--	--
1990	3 Jul	--	474	--	--	--	--	--	--	--
1991	17 Jul	--	124	--	--	--	--	--	--	--
1992	3 Jul	7.8	389	30 Jun	--	--	--	--	--	--
1993	8 Jul	--	119	--	--	--	--	--	--	--
1994	1 Jul	--	165	--	--	--	--	--	--	--
1995	13 Jul	9.9	39	13 Jul	359	<15 Jun	13 Jul	28 Jun	8 Aug	3 Aug
1996	4 Jul	12.0	223	2 Jul	426	<14 Jun	23 Jul	<14 Jun	4 Aug	19 Jul
1997	9 Jul	8.1	276	9 Jul	493	<9 Jun	9 Jul	17 Jun	7 Aug	31 Jul
1998	6 Jul	8.1	160	5 Jul	280	<14 Jun	5 Jul	16 Jun	4 Aug	4 Aug
1999	11 Jul	7.6	27	9 Jul	237	<24 Jun	9 Jul	28 Jun	4 Aug	16 Aug
2000	3 Jul	8.6	184	3 Jul	324	<11 Jun	10 Jul	12 Jun	1 Aug	1 Aug
2001	23 Jun	4.0	17	26 Jun	178	<17 Jun	20 Jun	17 Jun	1 Jul	>22 Aug
2002	27 Jun	5.3	147	29 Jun	299	<12 Jun	29 Jun	15 Jun	11 Jul	28 Jul
2003	10 Jul	4.3	21	8 Jul	272	<17 Jun	3 Jul	<22 Jun	<23 Jul	11 Aug
2004	27 Jun	5.4	34	28 Jun	239	<15 Jun	1 Jul	18 Jun	11 Jul	14 Aug

[a] Sample size is for the calculation of mean and median hatch dates. These data are a subsample for which we have observations $\leq$ 7 days apart from egg to chick.

[b] The total used for estimating the remaining parameters. These dates might contain observations > 7 days apart or estimated event dates (e.g. “no egg” on first visit followed by “bird incubating” on the next visit

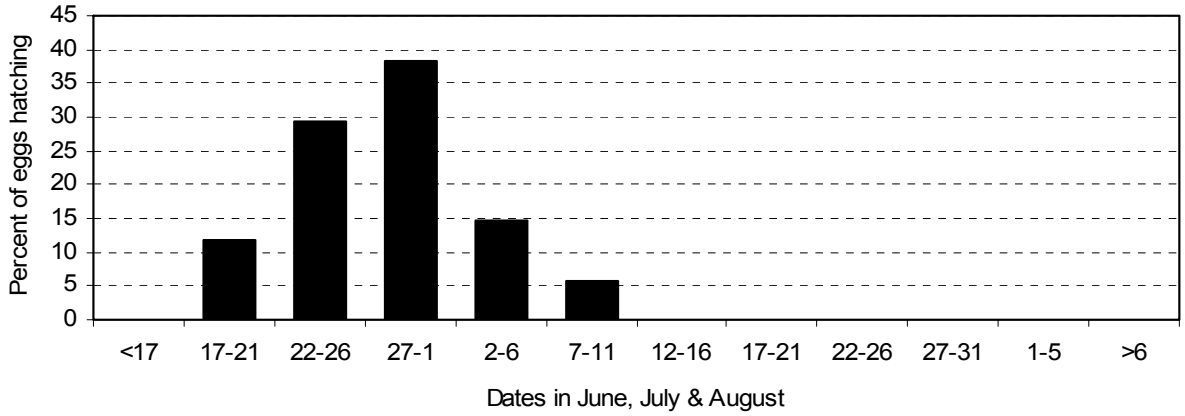

Figure 7. Hatching chronology of black-legged kittiwakes at Buldir Island, Alaska in 2004.

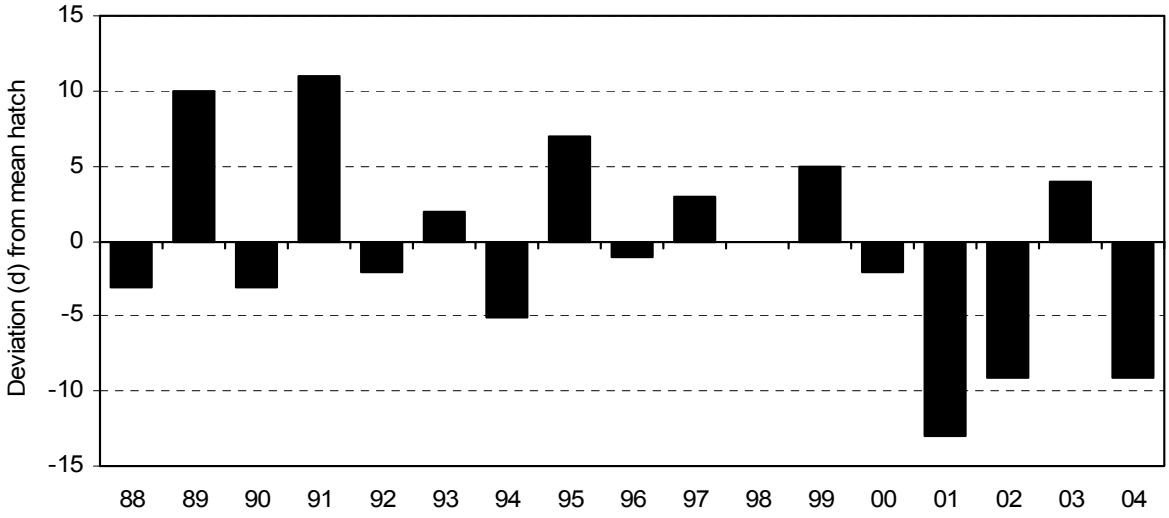

Figure 8. Yearly hatch date deviation (from the 1988-2004 average of 17 July) for black-legged kittiwakes at Buldir Island, Alaska. Numbers below the mean indicate hatch dates earlier, positive numbers indicate hatch dates later.

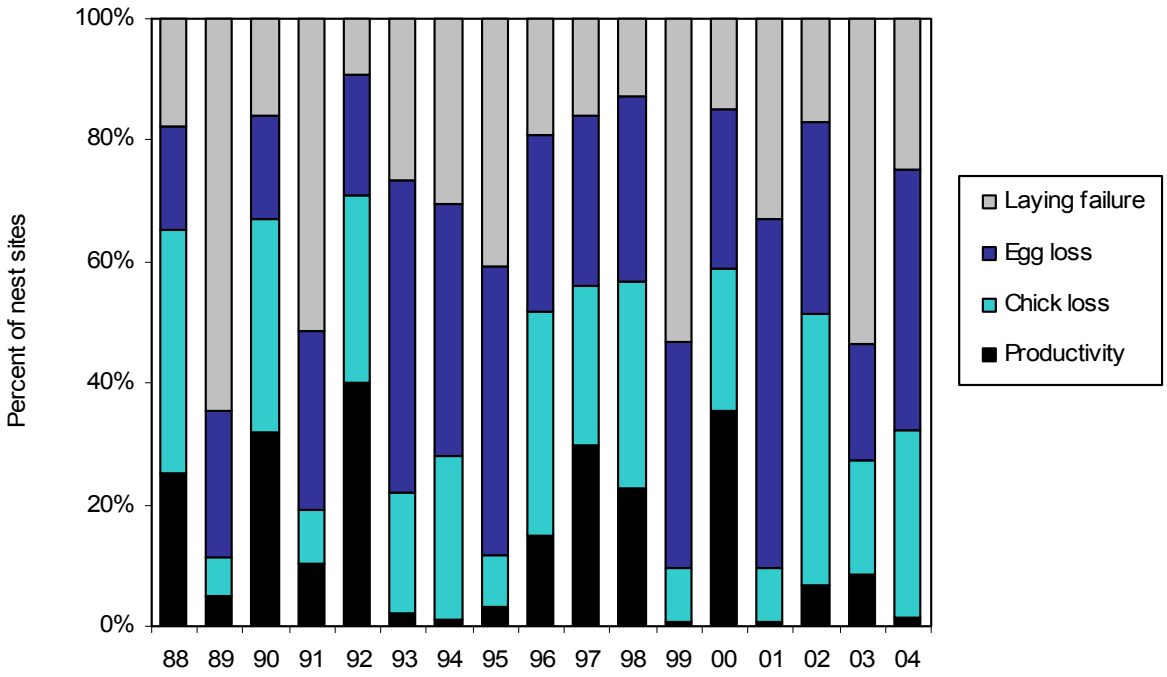

Figure 9. Reproductive performance of black-legged kittiwakes at Buldir Island, Alaska. Laying Failure=(A-B)/A; Egg Loss=(B-D)/A; Chick Loss=(D-F)/A; Productivity=F/A, where A=total number of nests; B=number of nests with ≥ 1 egg; D=number of nests with ≥ 1 chick; F=number of nests with ≥ 1 fledged chick

Table 22. Reproductive performance of black-legged kittiwakes at Buldir Island, Alaska.

Year	total nests	mean clutch	no. nests w/ eggs	no. nests w/ chicks	no. nests w/ fledged chick	laying success[a]	nesting success[b]	fledging success[c]	reproductive success[d]	productivity[e]
1976	--	1.61	--	--	--	--	--	--	--	--
1988	617	1.78	508	403	156	0.82	0.79	0.39	0.31	0.25
1989	564	1.22	201	64	28	0.36	0.32	0.44	0.14	0.05
1990	906	1.76	762	608	288	0.84	0.80	0.47	0.38	0.32
1991	719	1.35	350	138	74	0.49	0.39	0.54	0.21	0.10
1992	508	1.79	461	360	203	0.91	0.78	0.56	0.44	0.40
1993	533	1.58	391	118	12	0.73	0.30	0.11	0.03	0.02
1994	468	1.66	325	131	5	0.69	0.40	0.04	0.02	0.01
1995	359	1.41	213	42	11	0.59	0.20	0.29	0.05	0.03
1996	426	1.69	344	220	64	0.81	0.64	0.29	0.19	0.15
1997	493	1.73	415	277	146	0.84	0.67	0.53	0.35	0.30
1998	280	1.75	244	159	64	0.87	0.65	0.40	0.26	0.23
1999	237	1.49	111	26	2	0.47	0.23	0.08	0.02	0.01
2000	324	1.79	276	191	115	0.85	0.69	0.60	0.42	0.35
2001	178	--	119	17	1	0.67	0.14	0.06	0.01	0.01
2002	299	1.79	248	154	20	0.83	0.62	0.13	0.08	0.07
2003	213	1.51	99	58	18	0.46	0.59	0.31	0.18	0.08
2004	239	1.11	180	77	3	0.75	0.43	0.04	0.02	0.01

[a] Number of nests with ≥ 1 egg/total number of nests.
[b] Number of nests with ≥1 chick/number of nests with ≥ 1 egg.
[c] Number of nests where ≥ 1 chick fledged/total number of nests with ≥ 1 chick.
[d] Number of nests where ≥ 1 chick fledged/total number of nests with ≥ 1 egg.
[e] Number of nests where ≥ 1 chick fledged/total number of nests.

Table 23. Black-legged kittiwake clutch sizes at Buldir Island, Alaska.

	1976[a]	1988	1989	1990	1991	1992	1993	1994	1995
mean	1.61	1.78	1.22	1.76	1.35	1.79	1.58	1.66	1.41
n[b]	74	462	220	761	350	462	391	323	213
0	-	-	-	-	-	-	-	-	145
1	-	-	-	-	-	-	-	-	126
2	-	-	-	-	-	-	-	-	87
3	-	-	-	-	-	-	-	-	0

[a] Data from Byrd and Day (1986).
[b] Nest sites used as sample units.

Table 23 continued. Black-legged kittiwake clutch sizes at Buldir Island, Alaska.

	1996	1997	1998	1999	2000	2001	2002	2003	2004
mean	1.69	1.73	1.75	1.49	1.79	-	1.79	1.51	1.11
n[b]	344	415	244	237	324	-	299	99	239
0	82	78	36	126	48	-	51	114	69
1	107	111	64	57	59	-	54	49	75
2	236	304	178	54	216	-	193	50	95
3	1	0	2	0	1	-	1	0	0

[a] Data from Byrd and Day (1986).
[b] Nest sites used as sample units.

Table 24. Reproductive performance of black-legged kittiwakes on index plots at Buldir Island, Alaska, in 2004.

	Kittiwake Lane Plots								
Parameter	37A	39D	40	45	46	total	n	mean	SD
total nests (A)	30	49	69	57	34	239			
no. of nests with ≥ 1 egg (B)	20	30	55	42	33	180			
total eggs (C)	31	51	89	59	35	265			
no. of nests with ≥ 1 chick (D)	10	8	24	24	11	77			
total chicks (E)	11	8	25	30	14	88			
no. of nests where ≥ 1 chick fledged (F)	0	0	0	3	0	3			
total chicks fledged (G)	0	0	0	3	0	3			
nests with 1 egg	9	9	21	25	11	75			
nests with 2 eggs	11	21	34	17	12	95			
nests with 3 eggs	0	0	0	0	0	0			
laying succ. (B/A)	0.67	0.61	0.80	0.74	0.97		5	0.75	0.05
clutch size (C/B)	1.55	1.70	1.62	1.40	1.06		5	1.47	0.10
nesting succ. (D/B)	0.50	0.27	0.44	0.57	0.33		5	0.43	0.05
hatching success (E/C)	0.35	0.16	0.28	0.51	0.40		5	0.33	0.06
chick succ. (G/E)	0	0	0	0.10	0		5	0.03	0.03
egg success (G/C)	0	0	0	0.05	0		5	0.01	0.01
fledging success (F/D)	0	0	0	0.13	0		5	0.04	0.03
reproductive success (F/B)	0	0	0	0.07	0		5	0.02	0.02
overall productivity (F/A)	0	0	0	0.05	0		5	0.01	0.01

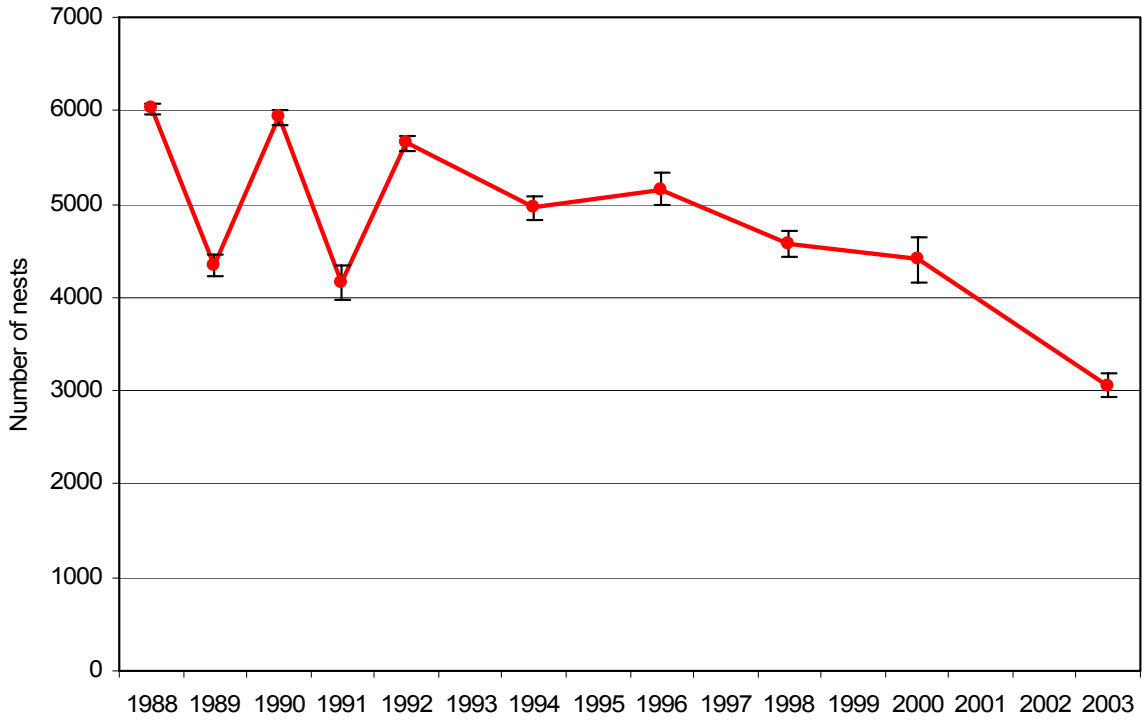

Figure 10. Counts of black-legged kittiwake nests on index plots at Buldir Island, Alaska. Error bars represent the standard deviation of counts in each year.

Table 25. Black-legged kittiwake nest population counts at Buldir Island, Alaska (The Dip, Kittiwake Lane East and Kittiwake Lane West combined).

Count	1988	1989	1990	1991	1992	1994	1996	1998	2000	2003
1	5972	4452	5844	4079	5569	5106	4966	4393	4464	3122
2	6070	4194	5845	4432	5663	5004	5246	4697	4786	3028
3	6013	4403	6020	4254	5757	4867	5329	4711	4179	3200
4	--	4247	6012	3949	5625	4856	4969	4545	4339	2885
5	--	4393	5934	4088	--	--	5297	4471	4246	
mean	6027.0	4337.8	5931.0	4160.4	5653.5	4958.3	5161.4	4564.4	4402.8	3058.8
n	3	5	5	5	4	4	5	5	5	4
SD	50.1	111.0	85.8	186.5	79.1	119.3	179.5	137.7	239.4	135.5
first survey	5 Jul	26 Jun	30 Jun	4 Jul	3 Jul	3 Jul	27 Jun	4 Jul	27 Jun	9 Jul
last survey	27 Jul	16 Jul	18 Jul	19 Jul	21 Jul	19 Jul	19 Jul	24 Jul	20 Jul	25 Jul

Table 26. Black-legged kittiwake bird population counts at Buldir Island, Alaska (The Dip, Kittiwake Lane East and Kittiwake Lane West combined).

Count	1988	1989	1990	1991	1992	1994	1996	1998	2000	2003
1	6797	6534	6977	5125	7226	6185	6072	5821	5272	4848
2	6998	6276	7042	5671	7607	6721	7036	6969	6020	4157
3	6418	7048	7423	5145	7302	6463	7382	7263	5150	4084
4	7115	7812	7141	5177	7484	6271	7483	6398	5267	2979
5	--	7450	7019	5468	--	--	7639	6600	6291	
mean	6832.0	7024.0	7120.4	5317.2	7404.8	6410.0	7122.4	6610.2	5600.0	4017.0
n	4	5	5	5	4	4	5	5	5	4
SD	305.7	633.0	98.9	242.0	172.9	237.7	627.5	552.9	518.4	772.9
first survey	5 Jul	26 Jun	30 Jun	4 Jul	3 Jul	3 Jul	27 Jun	4 Jul	27 Jun	9 Jul
last survey	27 Jul	16 Jul	18 Jul	19 Jul	21 Jul	19 Jul	19 Jul	24 Jul	20 Jul	25 Jul

Table 27. Black-legged kittiwake nest counts by sub-area at Kittiwake Lane (Slide Mountain Colony), Buldir Island, Alaska.

Segment (Plot)	1974	1975	1976	1988	1989	1990	1991	1992	1994	1996	1998	2000	2003
1 (15)		137		563	424	542	241	515	344	352	338	300	256
2 (16)		133		637	510	580	296	595	509	415	460	351	317
3 (17)		76		728	568	642	378	586	566	515	405	381	297
4 (18)		123		628	271	474	351	449	448	436	401	335	255
5 (19)		63		368	237	361	300	346	376	360	268	281	159
6 (20)		39		284	180	298	230	297	301	280	202	209	101
7 (21)		24		341	215	290	256	324	299	325	279	274	185
8 (22)		5		264	236	343	277	329	244	317	297	303	213
9 (23)		0		219	230	344	251	355	264	244	238	268	153
10 (24)		0		10	9	26	11	23	43	114	115	185	90
11 (25)		0		7	5	11	9	12	35	48	52	90	69
12 (26)		0		18	11	19	8	7	19	49	77	163	121
13 (27)		0		15	9	4	1	14	29	52	58	71	86
14 (28)		0		18	9	20	9	22	49	74	71	84	64
15 (29)		0		0	0	0	0	0	0	0	0	4	17
Total	649[a]	600	597	4100	2914	3954	2618	3874	3526	3581	3262	3299	2383
SD[b]	–	–	–	40.5	79.7	60.0	208.6	45.9	19.6	147.8	94.0	208.7	158.0
n	1	1	1	3	5	5	5	4	4	5	5	5	4
first survey	[c]	[c]	[c]	5 Jul	29 Jun	30 Jun	8 Jul	6 Jul	4 Jul	28 Jun	4 Jul	27 Jun	9 Jul
last survey	[c]	[c]	[c]	27 Jul	16 Jul	18 Jul	18 Jul	20 Jul	19 Jul	18 Jul	24 Jul	20 Jul	25 Jul

[a] Includes 44 *Rissa* spp.
[b] SD based on replicate counts of all plots, not the sum of the plot means as presented above
[c] From Byrd (1978); figures are from single counts made early to mid-July 1974, 1975, and 1976.

Table 28. Black-legged kittiwake nest counts by sub-area at Middle Rock, Buldir Island, Alaska.

Segment (Plot)	1974	1975	1976	1984	1988	1989	1990	1991	1992	1994	1996	1998	2001	2004
I	161	50	--	177	139	139	187	58	134	25	107	60	85	75
II	60	20	--	72	75	95	101	34	73	40	62	50	111	33
III	81	70	--	107	150	120	116	43	82	59	36	72	1	0
IV	95	11	--	155	94	60	67	18	26	108	75	32	46	19
V	59	80	--	106	87	183	211	96	151	61	139	118	78	95
VI	0	--	--	50	172	170	186	99	163	182	168	186	--	61
VII	0	--	--	0	313	274	250	190	216	198	267	200	160	207
Total	456	231	340	667	1030	1041	1118	538	845	673	854	718	481[a]	490
survey date	9 Aug	4 Jun	19 Jul	17 Jun	19 Jul	20 Jul	19-26 Jul	17 Jul	26 Jul	23-24 Jul	22 Jul	1 Jul	6 Jul	13 Jul

[a] Partial count, not for comparison.

Table 29. Black-legged kittiwake counts by sub-area at Middle Rock, Buldir Island, Alaska.

Segment (Plot)	1974	1975	1976	1984	1988	1989	1990	1991	1992	1994	1996	1998	2001	2004
I	--	--	--	--	206	342	211	229	239	--	161	125	136	122
II	--	--	--	--	135	225	128	111	120	--	96	111	139	132
III	--	--	--	--	241	175	125	68	106	--	40	102	0	0
IV	--	--	--	--	210	97	80	85	34	--	92	51	30	11
V	--	--	--	--	135	402	232	263	211	--	201	210	109	137
VI	--	--	--	--	300	296	203	309	236	--	241	271	94	92
VII	--	--	--	--	428	519	323	445	339	--	366	315	322	313
Total	--	--	--	--	1655	2056	1302	1510	1285	--	1197	1185	830	807
survey date	9 Aug	4 Jun	19 Jul	17 Jun	19 Jul	20 Jul	19-26 Jul	17 Jul	26 Jul	23-24 Jul	22 Jul	1 Jul	6 Jul	13 Jul

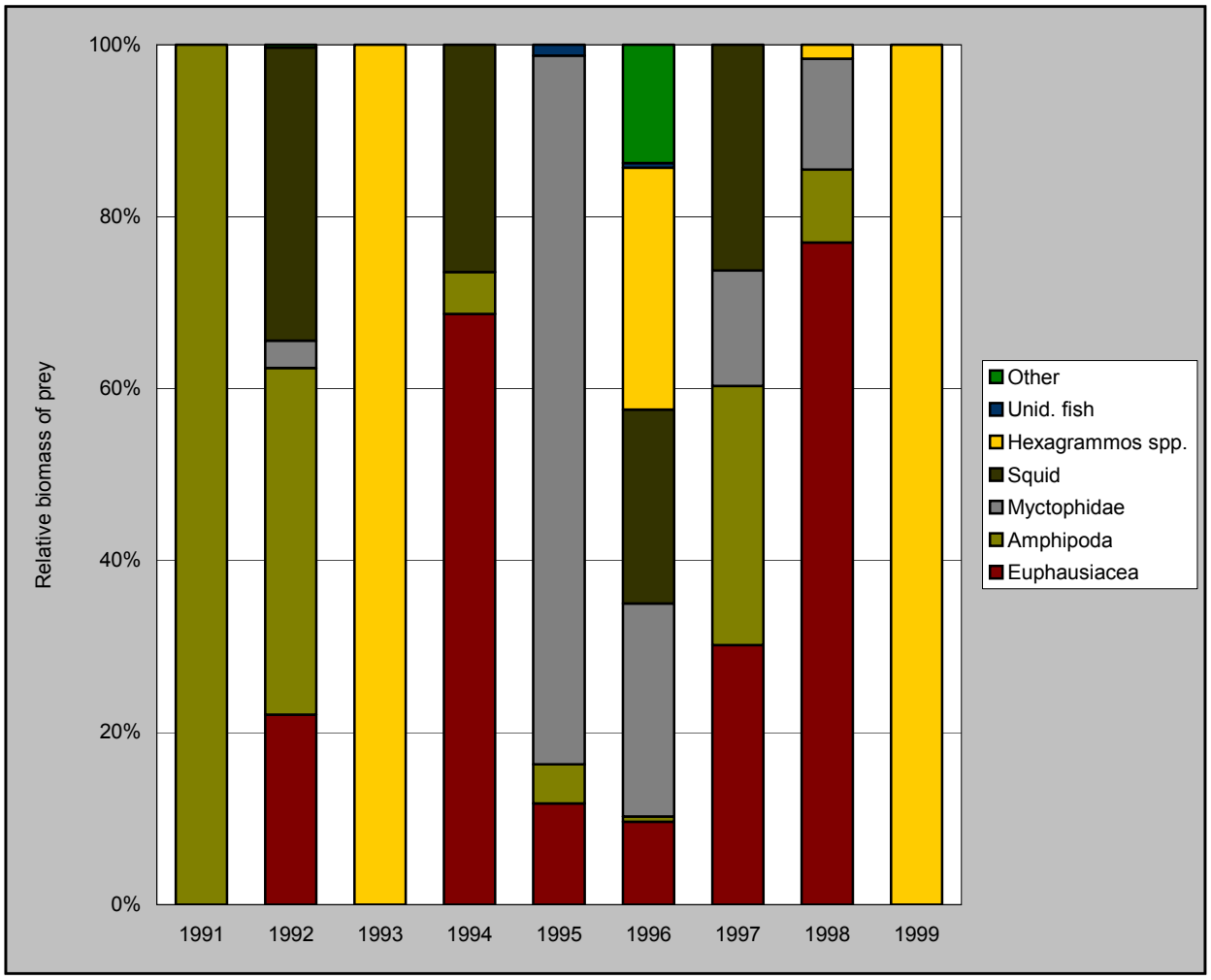

Figure 11. Relative biomass of prey in diets of black-legged kittiwakes at Buldir Island, Alaska.

Table 30. Relative biomass of prey in diets of black-legged kittiwakes at Buldir Island, Alaska. Numbers represent the percentage of the mass of combined food samples comprised by each species.

	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. samples	3	23	14	6	4	7	3	11	1
Total mass (g)	0.9	158.4	249.0	104.1	118.9	181.7	30.5	309.5	49.0
Cephalopoda - squid		34.1		26.4		22.6	26.2		
Copepoda									
Neocalanus plumchrus					2.3				
N. cristatus		2.4						8.2	
Amphipoda									
Hyperiidea									
Parathemisto pacifica		23.3		4.9	2.3	0.6	30.2	0.2	
Parathemisto spp.	43.2	13.0							
Gammaridea									
Lysianassidae	56.8	0.3				0.1		0.1	
Unid. Amphipoda		1.3							
Euphausiacea									
Thysanoessa spp.		22.1		68.7	11.8	9.6	30.2		
Unid. Euphausiid								77.0	
Decapoda - shrimp		0.3							
Fish									
Myctophidae									
Stenobrachius leucopsarus							13.4	12.9	
Unid. Myctophidae		3.2			82.4	24.8			
Hexagrammos spp.			100.0			28.1		1.6	100.0
Unid. fish					1.3	0.6			
Offal					13.8				

Table 31. Frequency of occurrence of prey in diets of black-legged kittiwakes at Buldir Island, Alaska. Frequency is expressed as the percentage of food samples in which each species was present.

	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. samples	3	23	14	6	4	7	3	11	1
Cephalopoda - squid		17.4		50.0		28.6	33.3		
Copepoda									
Neocalanus plumchrus					25.0				
N. cristatus		13.0						18.2	
Unid. Copepoda		4.3							
Amphipoda									
Hyperiidea									
Parathemisto pacifica		13.0		50.0	25.0	14.3	33.3	18.2	
Parathemisto spp.	33.3	17.4							
Gammaridea									
Lysianassidae	33.3	4.3				14.3		9.1	
Unid. Amphipoda		8.7							
Euphausiacea									
Thysanoessa spp.		47.8		83.3	25.0	14.3	33.3		
Unid. Euphausiid								81.8	
Decapoda - shrimp		4.3							
Fish									
Myctophidae									
Stenobrachius leucopsarus							66.7	27.3	
Unid. Myctophidae		43.5			75.0	28.6			
Ammodytes hexapterus	33.3	8.7							
Hexagrammos spp.			71.4			42.9		9.1	100.0
Unid. fish	33.3	4.3	28.6		25.0	14.3			
Offal					14.3				

Table 32. Breeding chronology dates for red-legged kittiwakes at Buldir Island Alaska.

Year	mean hatch	SD	n[a]	median hatch	no. nests monitored[b]	first lay	last lay	first hatch	last hatch	first fledge
1988	8 Jul	6.7	59	7 Jul	144	<21 Jun	28 Jun	28 Jun	1 Aug	6 Aug
1989	12 Jul	2.2	31	13 Jul	233	<12 Jun	25 Jun	8 Jul	13 Jul	>15 Aug
1990	7 Jul	6.9	110	5 Jul	218	3 Jun	3 Aug	22 Jun	25 Jul	31 Jul
1991	13 Jul	5.6	38	10 Jul	194	<14 Jun	27 Jul	1 Jul	22 Jul	10 Aug
1992	8 Jul	6.8	137	7 Jul	269	<4 Jun	20 Jul	20 Jun	30 Jul	5 Aug
1993	12 Jul	6.3	35	13 Jul	187	<7 Jun	13 Jul	1 Jul	23 Jul	16 Aug
1994	11 Jul	10.8	24	6 Jul	272	<15 Jun	30 Jun	25 Jun	6 Aug	12 Aug
1995	16 Jul	7.4	33	13 Jul	328	<15 Jun	17 Jul	7 Jul	8 Aug	>14 Aug
1996	12 Jul	9.7	62	13 Jul	206	<14 Jun	18 Jul	24 Jun	3 Aug	15 Jul
1997	15 Jul	7.1	73	13 Jul	259	<9 Jun	4 Jul	28 Jun	31 Jul	13 Aug
1998	13 Jul	6.0	62	12 Jul	147	<14 Jun	20 Jul	1 Jul	29 Jul	14 Aug
1999	13 Jul	10.7	18	11 Jul	126	<24 Jun	4 Jul	27 Jun	4 Aug	>19 Aug
2000	9 Jul	5.9	71	10 Jul	134	<11 Jun	10 Jul	27 Jun	27 Jul	13 Aug
2001	4 Jul	5.0	14	1 Jul	60	<17 Jun	26 Jun	26 Jun	17 Jul	none
2002	2 Jul	5.2	23	3 Jul	43	<6 Jun	<23 Jun	22 Jun	19 Jul	1 Aug
2003	13 Jul	--	1	13 Jul	17	<17 Jun	5 Jul	<30 Jun	13 Jul	16 Aug
2004	9 Jul	5.6	7	9 Jul	80	<15 Jun	13 Jul	25 Jun	<24 Jul	19 Aug

[a] Sample size is for the calculation of mean and median hatch dates. These dates are a subsample for which we have observations ≤7 days apart from egg to chick.

[b] The total used for estimating the remaining parameters. These dates might contain observations > 7 days apart or estimated event dates (e.g. No Egg on first visit followed by Bird Incubating on the next visit).

Table 33. Hatching dates of red-legged kittiwake nests by plot at Buldir Island, Alaska, 2004.

	July																													
Plot	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
All			2						3				1						1												

[a] Hatching dates are the mid-point or, if no mid-point, the even Julian date between plot visits. If more than 1 egg hatched, the date of the first egg was used

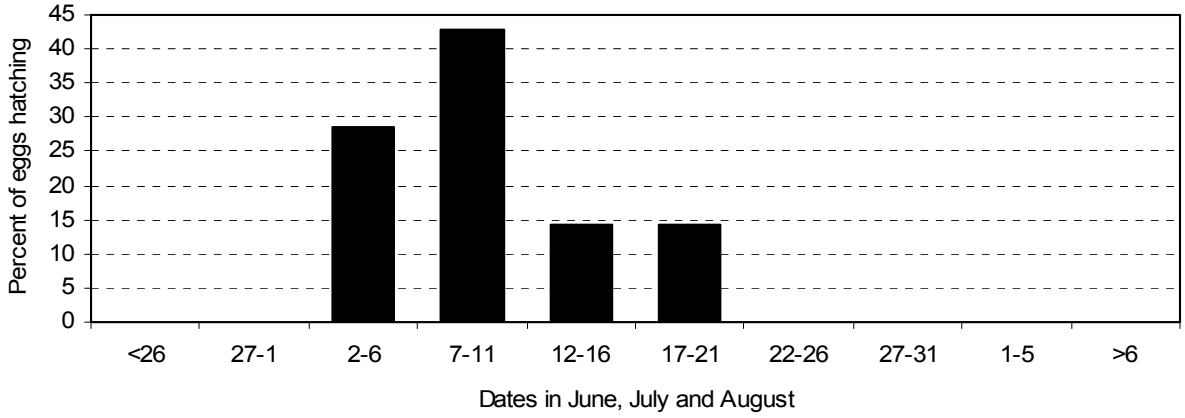

Figure 12. Hatching chronology of red-legged kittiwakes at Buldir Island, Alaska in 2004.

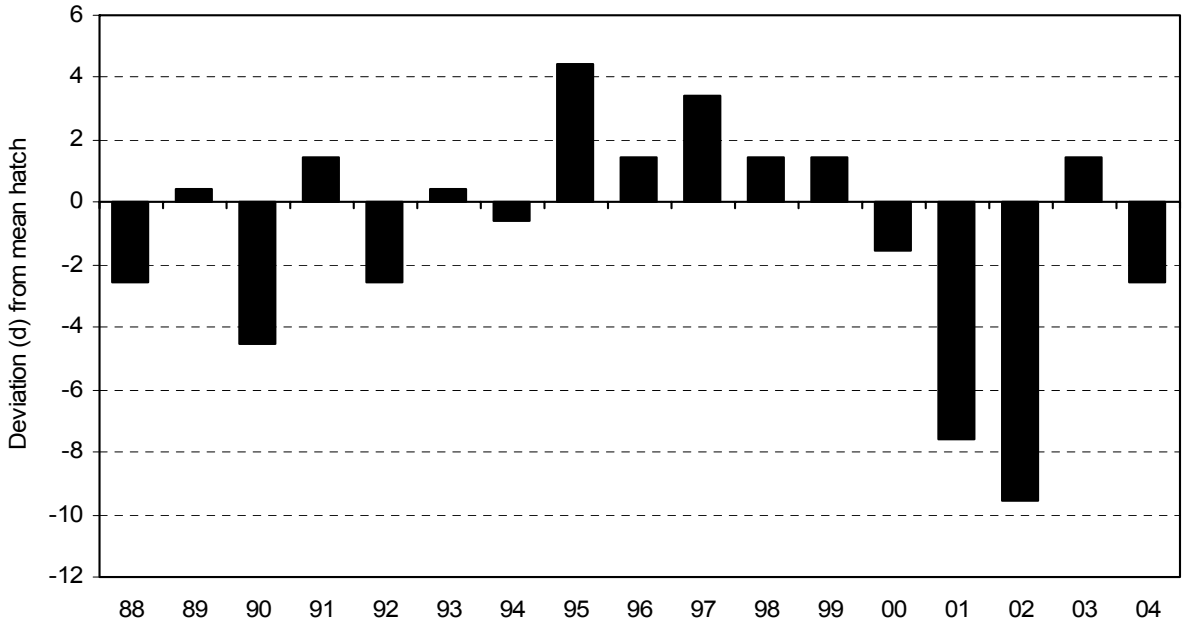

Figure 13. Yearly hatch date deviation (from the 1988-2004 average of 17 July) for red-legged kittiwakes at Buldir Island, Alaska. Numbers below the mean indicate hatch dates earlier, positive numbers indicate hatch dates later.

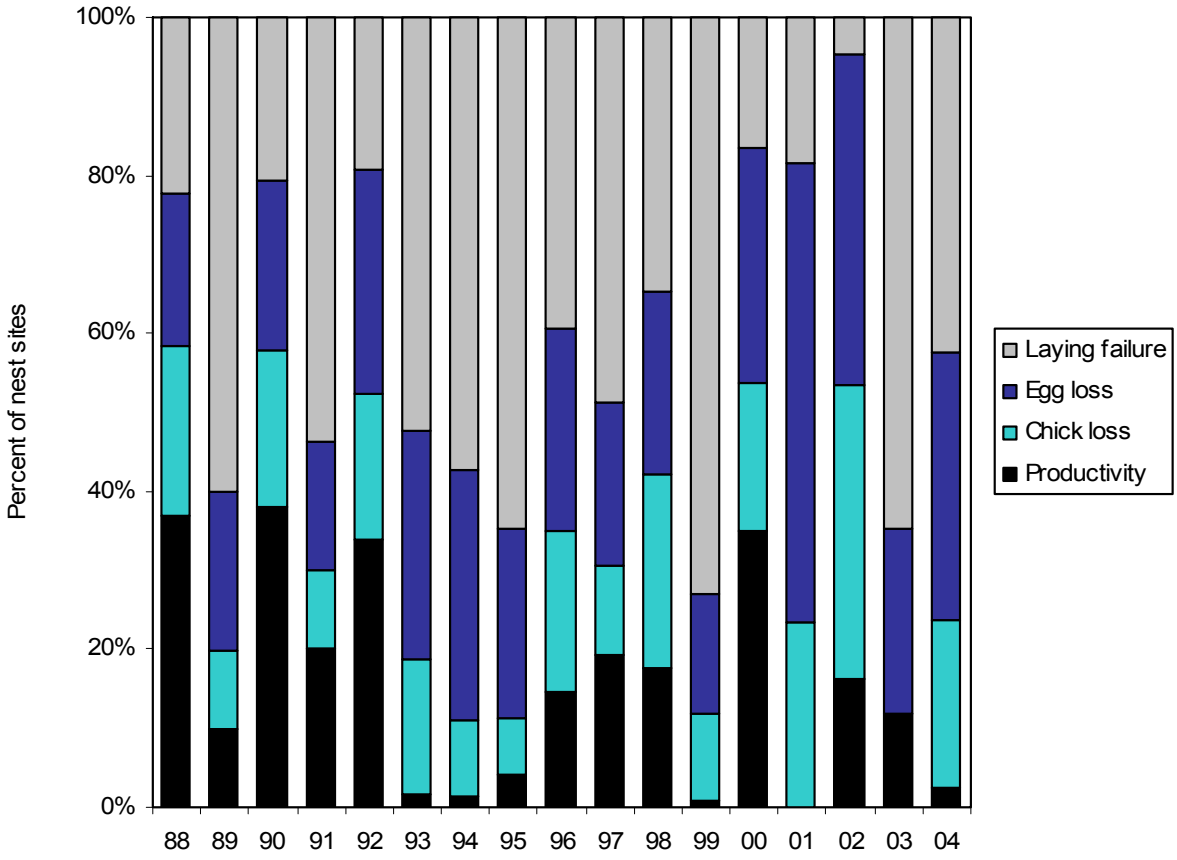

Figure 14. Reproductive performance of red-legged kittiwakes at Buldir Island, Alaska. Laying Failure=(A-B)/A; Egg Loss=(B-C)/A; Chick Loss=(C-D)/A; Productivity=D/A, where A=total number of nests; B=number of nests with ≥ 1 egg; C=number of nests with ≥ 1 chick; D= number of nests with ≥ 1 fledged chick.

Table 34. Reproductive performance of red-legged kittiwakes at Buldir Island, Alaska.

Year	total nests	no. nests w/ eggs	no. nests w/ chicks	no. nests w/ fledged chick	laying success[a]	nesting success[b]	fledging success[c]	reproductive success[d]	productivity[e]
1988	144	112	84	53	0.78	0.75	0.58	0.45	0.35
1989	233	93	46	23	0.40	0.49	0.50	0.25	0.10
1990	218	173	126	83	0.79	0.73	0.66	0.48	0.41
1991	194	90	58	39	0.46	0.64	0.67	0.43	0.20
1992	269	217	141	91	0.81	0.65	0.65	0.42	0.34
1993	187	89	35	3	0.48	0.44	0.09	0.03	0.02
1994	272	116	30	4	0.43	0.26	0.13	0.03	0.01
1995	328	116	37	14	0.35	0.32	0.38	0.12	0.04
1996	206	125	72	30	0.61	0.58	0.42	0.24	0.15
1997	259	133	79	50	0.51	0.59	0.63	0.38	0.19
1998	147	96	62	26	0.65	0.65	0.42	0.27	0.18
1999	126	34	15	1	0.27	0.44	0.07	0.03	0.01
2000	134	112	72	47	0.84	0.64	0.65	0.42	0.35
2001	60	47	14	0	0.78	0.30	0.00	0.00	0.00
2002	43	41	23	7	0.95	0.56	0.30	0.17	0.16
2003	17	6	2	2	0.35	0.33	1.00	0.33	0.12
2004	80	46	19	2	0.58	0.41	0.11	0.04	0.03

[a] Number of nests w/ eggs/number of nests.
[b] Number of nests with $\leq$ 1 chick/number of nests with $\leq$ 1 egg.
[c] Number of nests where $\leq$1 chick fledged/total number of nests with $\leq$ 1 chick.
[d] Number of nests where $\leq$ 1 chick fledged/total number of nests with $\leq$ 1 egg.
[e] Number of nests where $\leq$ 1 chick fledged/total number of nests.

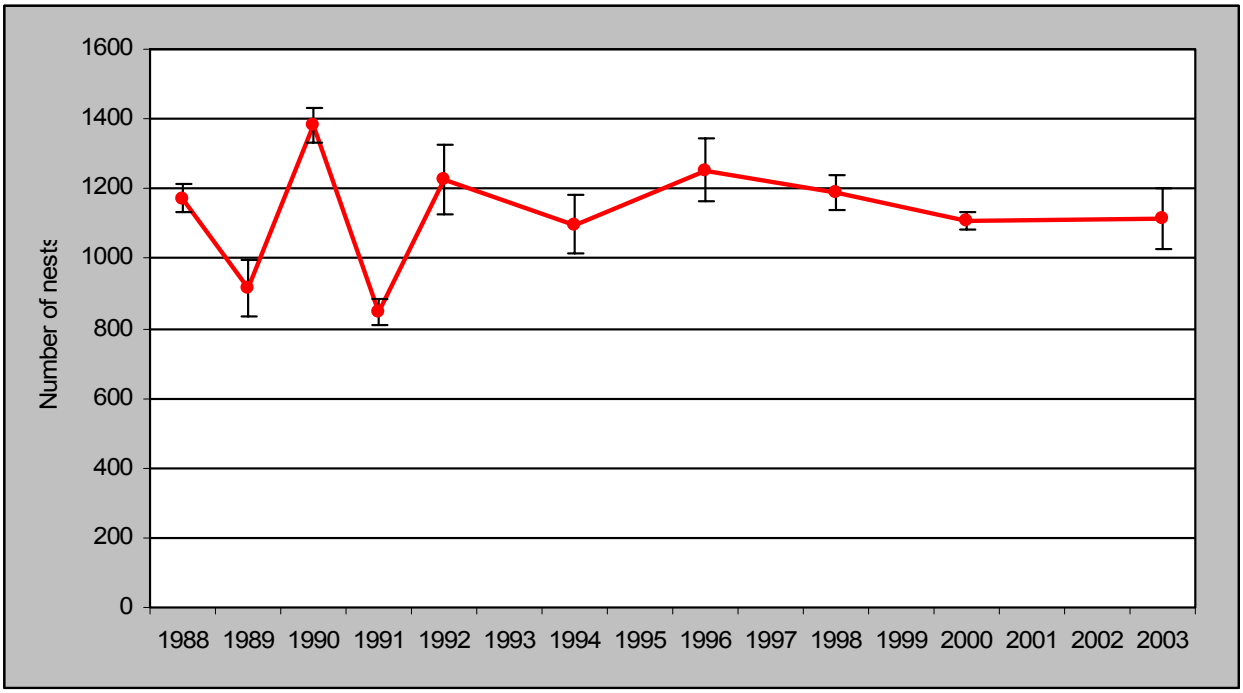

Figure 15. Counts of red-legged kittiwake nests on index plots at Buldir Island, Alaska. Error bars represent the standard deviation of replicate counts in each year.

Table 35. Red-legged kittiwake nest counts at Buldir Island, Alaska (The Dip, Kittiwake Lane East and Kittiwake Lane West combined).

Count	1988	1989	1990	1991	1992	1994	1996	1998	2001	2003
1	1182	826	1441	806	1094	1030	1133	1168	1120	984
2	1130	828	1415	835	1237	1060	1196	1112	1147	1139
3	1208	973	1315	874	1251	1082	1299	1239	1092	1156
4	--	957	1366	828	1330	1217	1366	1210	1084	1179
5	--	988	1367	895	--	--	1274	1215	1099	--
mean	1173.3	914.4	1380.8	847.6	1228.0	1097.3	1253.6	1188.8	1108.4	1114.5
n	3	5	5	5	4	4	5	5	5	4
SD	39.7	80.5	48.8	36.1	98.3	82.6	90.8	50.0	25.4	88.5
first survey	5 Jul	26 Jun	30 Jun	4 Jul	3 Jul	3 Jul	27 Jun	4 Jul	27 Jun	9 Jul
last survey	27 Jul	16 Jul	18 Jul	19 Jul	21 Jul	19 Jul	19 Jul	24 Jul	20 Jul	25 Jul

Table 36. Red-legged kittiwake counts at Buldir Island, Alaska (The Dip, Kittiwake Lane East and Kittiwake Lane West combined).

Count	1988	1989	1990	1991	1992	1994	1996	1998	2001	2003
1	1279	1220	1823	1139	1470	1387	1422	1506	1396	1630
2	1558	1389	1727	1165	1752	1466	1565	1487	1394	1790
3	1614	1533	1695	1320	1695	1565	1625	1582	1371	1742
4	1633	1560	1774	1320	1854	1747	1747	1605	1389	1602
5	--	1585	1811	1373	--	--	1697	1664	1455	--
mean	1521.0	1457.4	1766.0	1258.8	1692.8	1541.3	1611.2	1568.8	1401.0	1691.0
n	4	5	5	5	4	4	5	5	5	4
SD	164.4	152.9	54.5	101.7	162.4	155.3	126.4	72.8	31.8	89.5
first survey	5 Jul	26 Jun	30 Jun	4 Jul	3 Jul	3 Jul	27 Jun	4 Jul	27 Jun	9 Jul
last survey	27 Jul	16 Jul	18 Jul	19 Jul	21 Jul	19 Jul	19 Jul	24 Jul	20 Jul	25 Jul

Table 37. Red-legged kittiwake nest counts by sub-area at Kittiwake Lane (Slide Mountain Colony), Buldir Island, Alaska.

Segment (Plot)	1974	1975	1976	1988	1989	1990	1991	1992	1994	1996	1998	2000	2003
1 (15)	--	80	--	127	95	145	75	96	81	88	81	46	69
2 (16)	--	89	--	110	83	108	75	98	95	68	70	37	33
3 (17)	--	46	--	149	125	129	63	87	80	79	56	57	53
4 (18)	--	49	--	167	75	114	85	123	137	171	135	93	81
5 (19)	--	12	--	52	51	75	34	62	66	59	49	46	43
6 (20)	--	20	--	109	72	117	44	95	94	81	81	83	38
7 (21)	--	0	--	49	49	76	73	70	86	95	95	70	63
8 (22)	--	0	--	56	56	78	79	88	82	66	69	31	48
9 (23)	--	0	--	46	63	87	80	90	57	44	37	27	31
10 (24)	--	0	--	1	1	6	2	4	7	17	26	24	12
11 (25)	--	0	--	0	0	0	0	0	5	11	10	11	22
12 (26)	--	0	--	0	0	0	0	0	2	12	14	18	28
13 (27)	--	0	--	0	0	0	0	0	1	10	8	13	10
14 (28)	--	0	--	0	1	3	0	0	9	28	15	12	3
15 (29)	--	0	--	0	0	0	0	0	0	0	0	0	2
Total	289	296	299	866	671	938	611	813	802	829	746	568	536
SD[a]	–	–	–	27.1	25.9	36.5	33.1	21.3	17.9	30.6	31.9	53.8	59.3
n	1	1	1	3	5	5	5	4	4	5	5	5	4
first survey	[b]	[b]	[b]	5 Jul	29 Jun	30 Jun	8 Jul	6 Jul	4 Jul	28 Jun	4 Jul	27 Jun	9 Jul
last survey	[b]	[b]	[b]	27 Jul	16 Jul	18 Jul	18 Jul	20 Jul	19 Jul	18 Jul	24 Jul	20 Jul	25 Jul

[a] SD based on replicate counts of all plots, not the sum of the plot means as presented above.
[b] From Byrd (1978); figures are from single counts made early to mid-July 1974, 1975, and 1976.

Table 38. Red-legged kittiwake nest counts by sub-area at Middle Rock, Buldir Island, Alaska.

Segment (Plot)	1974	1975	1984	1988	1989	1990	1991	1992	1994	1996	1998	2001	2004
I	9	5	0	--	0	0	0	0	0	0	0	0	0
II	0	0	0	--	0	0	0	0	1	0	0	2	0
III	0	0	0	--	0	0	0	0	2	0	0	0	0
IV	0	0	0	--	0	0	0	0	0	0	0	0	0
V	1	2	1	--	0	0	0	0	0	0	0	1	0
VI	0	0	0	--	0	0	0	0	0	1	9	0	0
VII	0	0	0	--	0	2	4	4	0	1	0	2	2
Total	10	7	1	--	0	2	4	4	3	2	9	5	2
Survey date	9 Aug	4 Jun	17 Jun	19 Jul	20 Jul	19-26 Jul	17 Jul	26 Jul	23-24 Jul	22 Jul	1 Jul	6 Jul	13 July

Table 39. Red-legged kittiwake counts by sub-area at Middle Rock, Buldir Island, Alaska.

Segment (Plot)	1974	1975	1984	1988	1989	1990	1991	1992	1994	1996	1998	2001	2004
I	--	--	--	--	0	0	0	0	0	0	0	0	0
II	--	--	--	--	0	0	0	0	0	0	0	2	0
III	--	--	--	--	0	0	0	0	0	0	0	0	0
IV	--	--	--	--	0	0	0	0	0	0	0	0	0
V	--	--	--	--	3	0	0	0	0	0	5	1	0
VI	--	--	--	--	0	0	0	0	0	1	13	0	0
VII	--	--	--	--	4	3	8	4	0	3	0	4	6
Total	--	--	--	--	7	3	8	4	0	4	18	7	6
Survey date	9 Aug	4 Jun	17 Jun	19 Jul	20 Jul	19-26 Jul	17 Jul	26 Jul	23-24 Jul	22 Jul	1 Jul	6 Jul	13 Jul

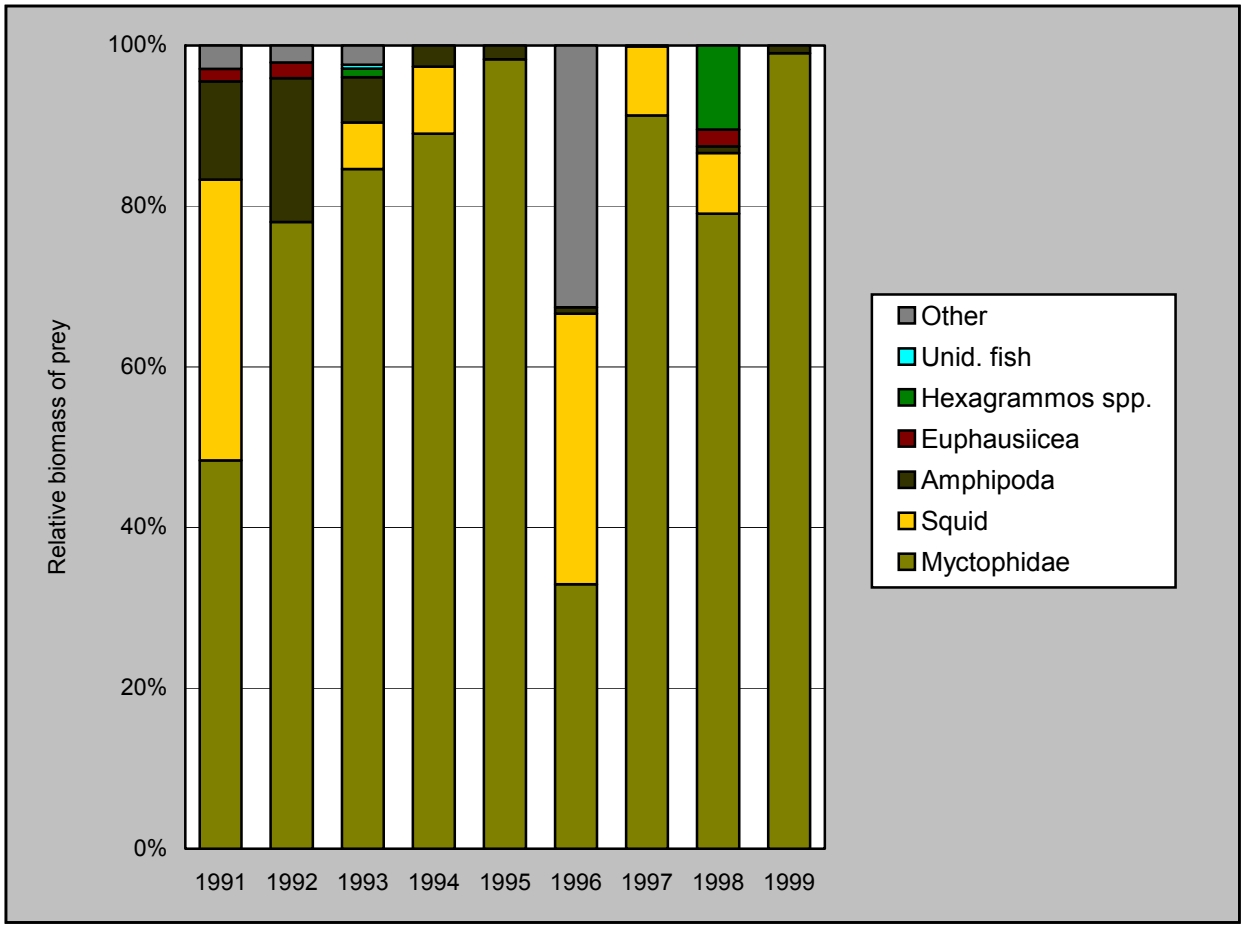

Figure 16. Relative biomass of prey in diets of red-legged kittiwakes at Buldir Island, Alaska.

Table 40. Relative biomass of prey in diets of red-legged kittiwakes at Buldir Island, Alaska. Numbers represent the percentage of the mass of combined food samples comprised by each species.

	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. samples	18	26	39	27	13	6	8	9	2
Total mass (g)	171.5	47.9	189.8	389.3	145.5	136.6	174.4	238.9	57.0
Cephalopoda - squid	35.0		5.8	8.3		33.7	8.6	7.5	
Amphipoda									
Hyperiidea									
Parathemisto pacifica				0.2					
Parathemisto spp.		3.3	0.6						
Gammaridea									
Lysianassidae	9.6	10.4	5.0	2.4	1.7	0.8	0.1	0.8	0.9
Unid. Amphipoda	2.6	4.2							
Euphausiacea									
Thysanoessa spp.	1.5	2.0							
Unid Euphausiid								2.1	
Decapoda - shrimp	2.9	2.1	1.1						
Fish									
Osmeridae			1.3						
Myctophidae									
Stenobrachius leucopsarus			84.6				91.3	69.0	
Unid. Myctophidae	48.3	78.0		89.0	98.3	32.9		10.0	99.1
Hexagrammos spp.			1.1					10.5	
Unid. fish			0.5						
Offal						32.6			

Table 41. Frequency of occurrence of prey in diets of red-legged kittiwakes at Buldir Island, Alaska. Frequency is expressed as the percentage of food samples in which each species was present.

	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. samples	18	26	39	27	13	6	8	9	2
Cephalopoda - squid	11.1		10.3	14.8		33.3	12.5	11.1	
Amphipoda									
Hyperiidea									
Parathemisto pacifica				7.4					
Parathemisto spp.		15.4	7.7						
Gammaridea									
Lysianassidae	44.4	19.2	20.5	40.7	30.8	33.3	12.5	22.2	50.0
Unid. Amphipoda	16.7	3.8							
Euphausiacea									
Thysanoessa spp.	16.7	7.7							
Unid Euphausiid								11.1	
Decapoda - shrimp	33.3	7.7	10.3						
Fish									
Osmeridae			2.6						
Myctophidae									
Stenobrachius leucopsarus			82.1				87.5	88.9	
Myctophidae - not *S. leuco.*			2.6					22.2	
Unid. Myctophidae	55.6	84.6		100.0	100.0	33.3			100.0
Ammodytes hexapterus	5.6								
Hexagrammos spp.			2.6					44.4	
Unid. fish	16.7	3.8	10.3		7.7				
Offal						33.3			

Table 42. Breeding chronology dates for thick-billed murres at Buldir Island Alaska.

Year	mean hatch	SD	n[a]	median hatch	no. nests monitored[b]	first lay	last lay	first hatch	last hatch	first jump	last jump
1988	20 Jul	8.9	38	17 Jul	363	23 Jun	23 Jul	11 Jul	19 Aug	3 Aug	28 Aug
1989	22 Jul	6.1	42	21 Jul	545	14 Jun	22 Jul	14 Jul	10 Aug	2 Aug	>16 Aug
1990	12 Jul	5.7	60	13 Jul	473	6 Jun	10 Jul	7 Jul	3 Aug	23 Jul	>14 Aug
1991	20 Jul	4.4	195	21 Jul	514	14 Jun	19 Jul	15 Jul	27 Jul	3 Aug	>13 Aug
1992	16 Jul	7.1	39	14 Jul	345	7 Jun	17 Jul	4 Jul	3 Aug	29 Jul	>12 Aug
1993	15 Jul	5.5	89	15 Jul	271	14 Jun	12 Jul	5 Jul	31 Jul	24 Jul	>15 Aug
1994	19 Jul	7.6	44	19 Jul	385	13 Jun	22 Jul	5 Jul	12 Aug	25 Jul	26 Aug
1995	19 Jul	5.0	178	19 Jul	288	8 Jun	13 Jul	11 Jul	10 Aug	28 Jul	>17 Aug
1996	13 Jul	5.9	179	14 Jul	308	14 Jun	16 Jul	2 Jul	12 Aug	18 Jul	18 Aug
1997	11 Jul	5.7	182	11 Jul	407	12 Jun	18 Jul	2 Jul	11 Aug	27 Jul	--
1998	16 Jul	5.6	56	15 Jul	271	<14 Jun	15 Jul	5 Jul	13 Aug	20 Jul	21 Aug
1999	22 Jul	5.8	31	21 Jul	269	<27 Jun	19 Jul	16 Jul	12 Aug	2 Aug	>14 Aug
2000	15 Jul	6.5	263	14 Jul	329	<14 Jun	6 Jul	3 Jul	7 Aug	19 Jul	21 Aug
2001	15 Jul	6.5	59	13 Jul	181	<17 Jun	15 Jul	27 Jun	21 Aug	27 Jul	21 Aug
2002	13 Jul	5.2	50	11 Jul	238	<6 Jun	7 Jul	8 Jul	9 Aug	28 Jul	26 Aug
2003	20 Jul	6.9	150	19 Jul	316	<17 Jun	10 Jul	20 Jun	11 Aug	10 Jul	>26 Aug
2004	20 Jul	6.6	97	19 Jul	213	11 Jun	29 Jul	9 Jul	11 Aug	29 Jul	>24 Aug

[a] Sample size is for the calculation of mean and median hatch dates. These dates are a subsample for which we have observations < 7 days apart from egg to chick.

[b] The total used for estimating the remaining parameters. These dates might contain observations > 7 days apart or estimated event dates (e.g. "no egg" on first visit followed by "bird incubating" on the next visit).

Table 43. Hatching dates of thick-billed murre eggs by plot at Buldir Island, Alaska, 2004[a].

	July																													
Plot	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
38b										2				10			1	1		13				5						1			
39a														1				1		1			1	1						2			
39b														1						1													
39c														1				1		1				2									
40														6						5										2			
45														2	1					8				8									
46														1						4				4						1			

Table 43 (continued).

	Aug																														
Plot	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
38b																															
39a							1																								
39b																															
39c				1																											
40									1																						
45	2																														
46	1				2																										

[a] Hatching dates are the mid-point or, if no mid-point, the even Julian date between plot visits. If more than 1 egg hatched, the date of the first egg was used.

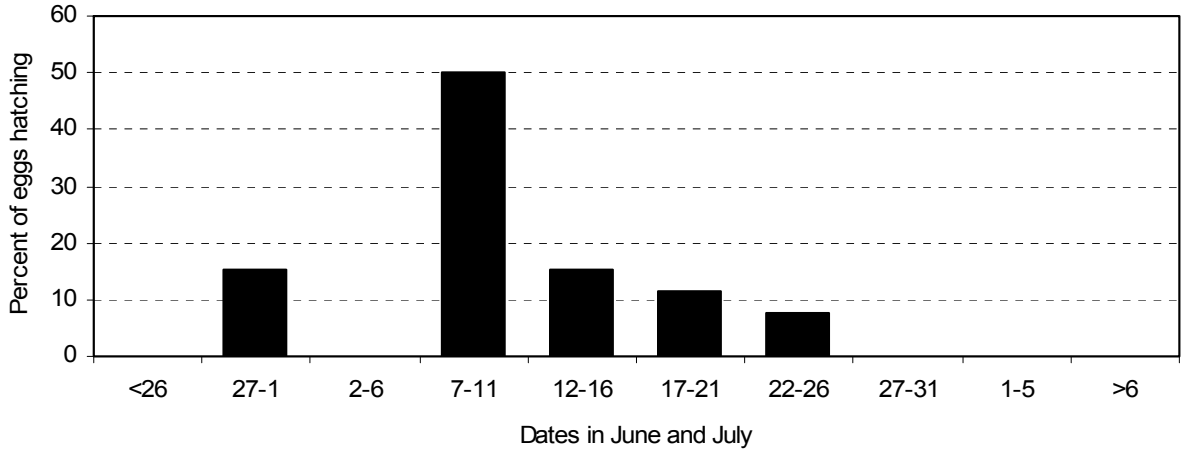

Figure 17. Hatching chronology of thick-billed murres at Buldir Island, Alaska in 2004.

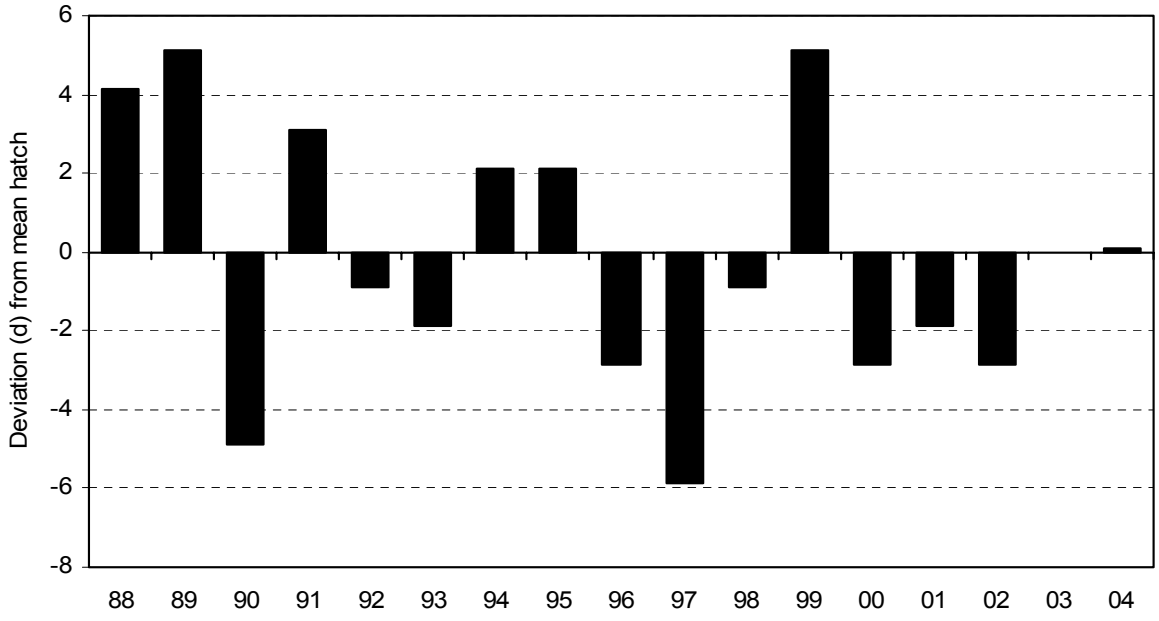

Figure 18. Yearly hatch date deviation (from the 1988-2004 average of 17 July) for thick-billed murres at Buldir Island, Alaska. Numbers below the mean indicate hatch dates earlier, positive numbers indicate hatch dates later.

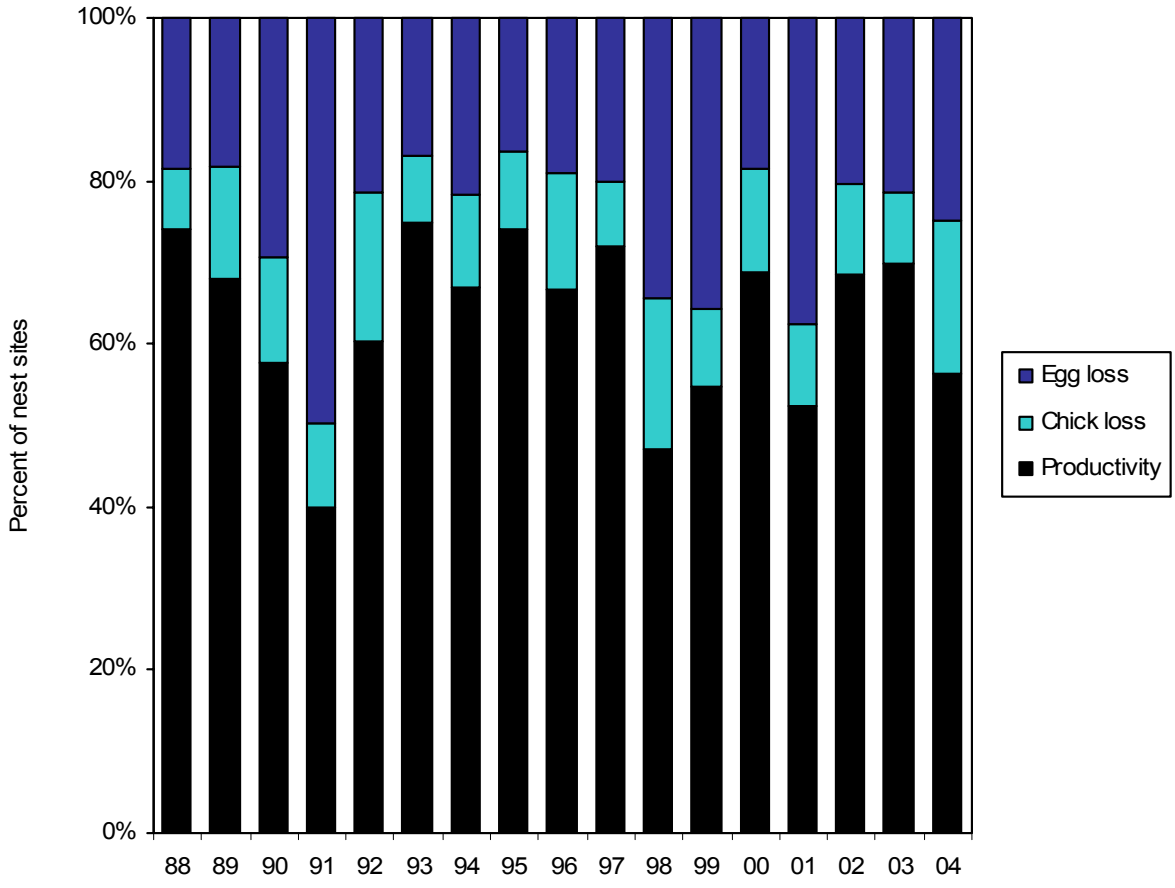

Figure 19. Reproductive performance of thick-billed murres at Buldir Island, Alaska. Egg Loss=(A-B)/A; Chick Loss=(B-C)/A; Productivity=C/A, where A=number nest sites, B=number of nest sites with a chick; C=number of nests sites with fledged chick.

Table 44. Reproductive performance of thick-billed murres on index plots at Buldir Island, Alaska.

Year[a]	no. sites w/ egg	no. sites w/ chick	no. sites w/ fledged chick	Hatching success[b]	Fledging success[c]	Reproductive success[d]
1988	362	295	268	0.80	0.90	0.73
1989	329	269	224	0.82	0.83	0.68
1990	473	334	273	0.82	0.94	0.76
1991	514	258	205	0.79	0.80	0.64
1992	350	275	211	0.79	0.77	0.60
1993	272	226	204	0.83	0.90	0.75
1994	385	301	258	0.78	0.86	0.67
1995	288	241	213	0.84	0.88	0.74
1996	308	249	205	0.81	0.82	0.67
1997	407	325	293	0.80	0.90	0.72
1998	270	177	127	0.65	0.71	0.47
1999	268	172	147	0.64	0.85	0.55
2000	329	268	226	0.81	0.84	0.69
2001	181	113	95	0.62	0.84	0.52
2002	239	190	164	0.79	0.86	0.69
2003	316	248	221	0.78	0.89	0.70
2004	213	160	120	0.75	0.75	0.56

[a] Data from: 1988, Byrd and Climo (1988); 1989, Byrd and Douglas (1989); 1990, Hipfner et al. (1991); 1991, Williams and Byrd (1992); 1992, summary tables; 1993, summary tables; 1994 summary tables, 1995, Williams et al. (1997a), 1996, Williams et al. (1997b), 1997, Williams et al. (1998).
[b] Number of sites with chick / no. sites with an egg.
[c] Number of sites where chick fledged / no. sites with a chick.
[d] Number of sites where chick fledged / no. sites with an egg.

Table 45. Reproductive performance of thick-billed murres on index plots at Buldir Island, Alaska, in 2004.

	Plot								Statistics	
Parameter	38b	39a	39b	39c	40	45	46	Total	n	mean	SD
no. of sites with an egg (A)	87	19	6	14	25	38	24	213			
no. of sites with chick (B)	65	13	3	12	19	31	17	160			
no. of sites where chick fledged (C)	53	8	2	7	15	25	10	120			
hatching success (B/A)	0.75	0.68	0.50	0.86	0.76	0.82	0.71		7	0.75	0.02
fledging success (C/B)	0.82	0.62	0.67	0.58	0.79	0.81	0.59		7	0.75	0.04
reproductive success (C/A)	0.61	0.42	0.33	0.50	0.60	0.66	0.42		7	0.56	0.04

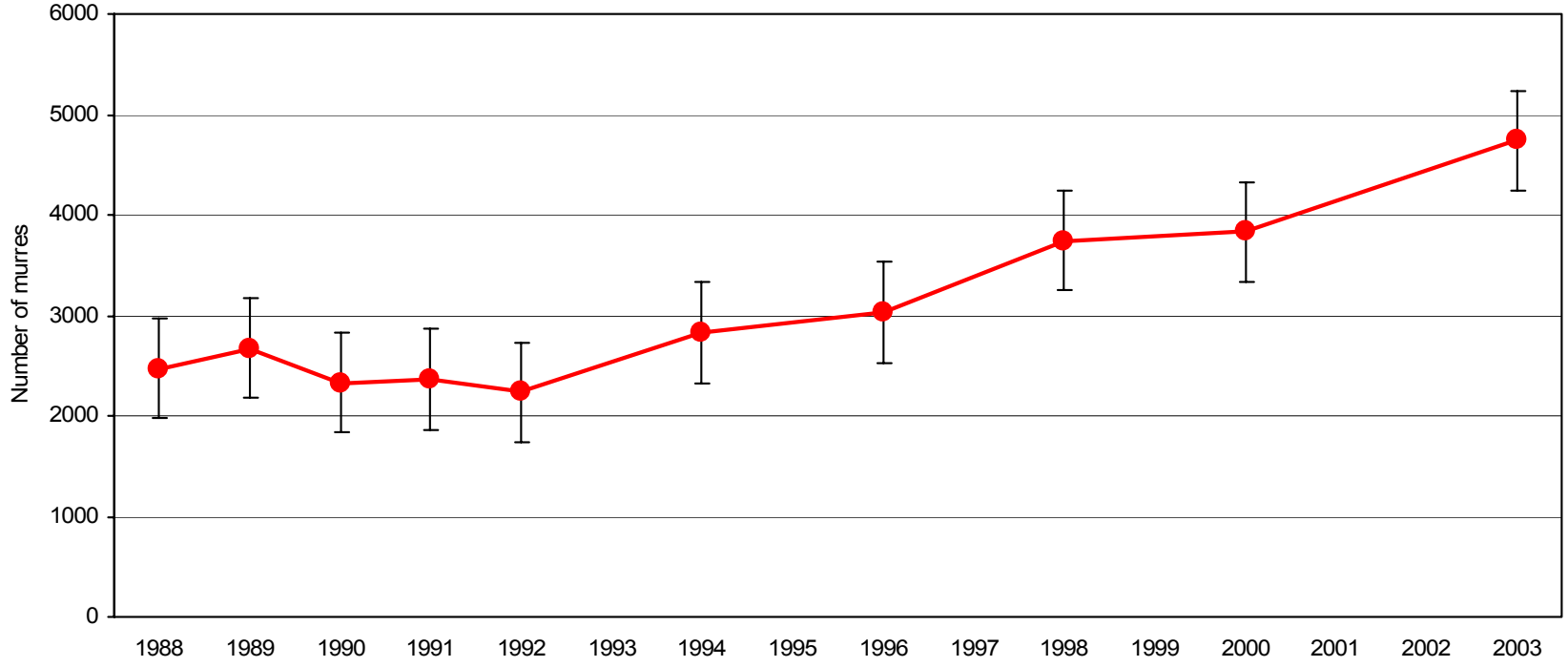

Figure 20. Counts of thick-billed murres on index plots at Buldir Island, Alaska. Error bars represent the standard deviation of replicate counts in each year.

Table 46. Thick-billed murre population counts at Buldir Island, Alaska (The Dip and Kittiwake Lane East & West combined).

Count	1988	1989	1990	1991	1992	1994	1996	1998	2000	2003
1	2224	2637	2306	2245	2127	3046	3177	3575	3787	4362
2	2487	2529	2379	2504	2195	2662	2863	3970	3791	4544
3	2602	2798	2488	2354	2476	2758	3064	3812	3704	4482
4	2464	2704	2237	2350	2135	2837	2775	3848	4086	5572
5	2577	2692	2254	2386	--	--	3283	3522	3796	--
mean	2470.8	2672.0	2332.8	2367.8	2233.3	2825.8	3032.4	3745.4	3832.8	4740.0
n	5	5	5	5	4	4	5	5	5	4
SD	149.8	98.7	102.9	92.8	164.7	163.3	211.9	190.0	146.5	559.8
first survey	5 Jul	26 Jun	30 Jun	4 Jul	3 Jul	3 Jul	27 Jun	4 Jul	27 Jun	9 Jul
last survey	27 Jul	16 Jul	18 Jul	19 Jul	21 Jul	19 Jul	19 Jul	24 Jul	20 Jul	25 Jul

Table 47. Thick-billed murre counts by sub-area at Kittiwake Lane (Slide Mountain Colony), Buldir Island, Alaska.

Segment (Plot)	1974	1975	1976	1988	1989	1990	1991	1992	1994	1996	1998	2000	2003
15 (1)		20		73	70	93	65	73	85	88	163	116	146
16 (2)		43		99	167	144	126	119	195	158	370	407	343
17 (3)		37		113	125	112	116	78	145	136	101	230	273
18 (4)		35		71	67	55	85	57	121	149	94	145	114
19 (5)		0		0	0	0	0	0	0	0	31	81	119
20 (6)		0		0	0	0	13	22	42	46	88	135	99
21 (7)		0		0	0	0	0	0	0	0	0	0	16
22 (8)		0		0	0	0	0	0	0	0	0	0	11
23 (9)		0		0	0	0	0	0	0	0	0	0	0
24(10)		0		0	0	0	0	0	0	0	0	0	0
25(11)		0		0	0	0	0	0	0	0	0	0	0
26(12)		0		0	0	0	0	0	0	0	0	0	0
27(13)		0		0	0	0	0	0	0	0	0	0	0
28(14)		0		0	0	0	0	0	24	67	82	103	190
29(15)		0		0	0	0	0	0	0	0	0	0	21
Total	173	135	135	355	429	404	406	349	612	645	928	1217	1332
SD[a]	–	–	–	38.5	76	40.3	56.4	43.0	79.0	66.3	62.3	140.9	366.5
n	1	1	1	6	5	5	5	4	4	5	5	5	4
first survey	[b]	[b]	[b]	5 Jul	29 Jun	30 Jun	8 Jul	6 Jul	4 Jul	28 Jun	4 Jul	27 Jun	9 Jul
last survey	[b]	[b]	[b]	27 Jul	16 Jul	18 Jul	18 Jul	20 Jul	19 Jul	18 Jul	24 Jul	20 Jul	25 Jul

[a] SD based on replicate counts of all plots, not the sum of the plot means as presented above
[b] From Byrd (1978); figures are from single counts made early to mid-July 1974, 1975, and 1976.

Table 48. Thick-billed murre counts by sub-area at Middle Rock, Buldir Island, Alaska.

Segment (Plot)	1974	1975	1976	1984	1988	1989	1990	1991	1992	1994	1996	1998	2001	2004
I	--	170	--	208[c]	147[d]	306	194	170	241	309	398	307	266	476
II	--	70	--	69	74	133	85	51	63	115	155	132	244	283
III	--	10	--	69	47	34	37	0	24	46	20	61	42	31
IV	--	0	--	149	28	111	104	39	62	253	188	196	184	162
V	--	65	--	23	0	72	58	34	56	42	172	129	146	282
VI	--	0	--	0	44	69	56	65	67	82	89	102	120	114
VII	--	0	--	0	341	740	566	456	520	485	641	697	701	823
Total	340[a]	315	405[b]	518	681	1465	1100	815	1033	1332	1663	1624	1703	2171
survey date	9 Aug	4 Jun	19 Jul	17 Jun	19 Jul	20 Jul	19-26 Jul	17 Jul	26 Jul	23-24 Jul	22 Jul	1 Jul	6 Jul	13 Jul

[a] In addition, 22 common murres were observed.
[b] In addition, 28 common murres were observed.
[c] In addition 31 common murres observed in segment I.
[d] In addition 35 common murres observed in segment.

Table 49. Breeding chronology dates for common murres at Buldir Island, Alaska.

Parameter	1997	1998	1999	2000	2001	2002	2003	2004
mean hatch	22 Jul	21 Jul	30 Jul	14 Jul	12 Jul	13 Jul	21 Jul	15 Jul
SD (days)	13.3	9.5	4.2	7.8	1.7	5.1	8.3	3.1
n[a]	8	4	2	15	3	7	7	6
median hatch	18 Jul	18 Jul	--	9 Jul	13 Jul	11 Jul	19 Jul	13 Jul
mean jump	6 Aug	16 Aug	--	6 Aug	9 Aug	3 Aug	13 Aug	3 Aug
SD (days)	6.4	6.0	--	10.6	5.0	6.5	6.1	8.1
n[b]	11	6	--	12	3	5	6	3
median jump	11 Aug	17 Aug	>14 Aug	7 Aug	6 Aug	5 Aug	11 Aug	29 Jul
no. nests monitored[c]	18	11	8	22	7	10	15	16
first hatch	11 Jul	15 Jul	27 Jul	6 Jul	10 Jul	7 Jul	13 Jul	13 Jul
last hatch	6 Aug	4 Aug	2 Aug	2 Aug	13 Jul	23 Jul	31 Jul	2 Aug
first jump	6 Aug	4 Aug	>14 Aug	24 Jul	6 Aug	23 Jul	6 Aug	29 Jul
last jump	16 Aug	19 Aug	>14 Aug	21 Aug	15 Aug	9 Aug	24 Aug	22 Aug

[a] Sample size is for the calculation of mean and median hatch dates. These dates are a subsample for which we have observations < 7 days apart from egg to chick.
[b] Sample size is for the calculation of mean and median jump dates.
[c] The total used for estimating the remaining parameters. These dates might contain observations > 7 days apart or estimated event dates (e.g. “no egg” on first visit followed by “bird Incubating” on the next visit)

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Table 50. Reproductive performance of common murres at Buldir Island, Alaska.

Parameter	1997	1998	1999	2000	2001	2002	2003	2004
no. sites w/ egg (A)	18	11	8	22	7	10	15	16
no. sites w/ chick (B)	16	7	2	16	3	7	11	12
sites where chick fledged (C)	13	6	1	12	3	5	6	6
hatching success (B/A)	0.89	0.64	0.25	0.73	0.43	0.70	0.73	0.75
fledging success (C/B)	0.81	0.86	0.50	0.75	1.00	0.71	0.55	0.50
reproductive success (C/A)	0.72	0.55	0.13	0.55	0.43	0.50	0.40	0.38

Table 51. Counts of pigeon guillemots at Buldir Island, Alaska.

Coastline section	1972[a]	1979	1997	1998	1999	2000	2001	2002
A-B	--	15	13	8	18	5	11	9
B-C	--	9	10	3	15	4	4	15
C-D	--	19	1	6	11	5	7	3
D-E	--	8	11	8	9	2	7	9
E-F	--	8	20	6	4	6	7	14
F-A	--	14	12	5	18	7	6	14
Total	60	73	67	36	75	29	42	64
Date		24-24 Jun	3 Jun	13 Jun	1 Jul	20 Jun	5 Jun	2 Jul

[a] Boat count conducted by Byrd (1972) 7 July 1972 on south side of island (50 individuals). Approximately 10 individuals were counted along the north shore 30 June - 8 July 1972.

Table 52. Breeding chronology dates for least auklets at Buldir Island Alaska.

Year	mean hatch	SD	n[b]	median hatch	mean fledge	SD	n[c]	median fledge	no. nests monitored[d]	first hatch	last hatch	first fledge	last fledge
1976[a]	2 Jul	3.6	15	2 Jul	--	--	--	--	15	27 Jun	10 Jun	--	--
1990	27 Jun	6.3	10	1Jul	--	--	23	28 Jul	61	21 Jun	9 Jul	19 Jul	>1 Aug
1991	30 Jun	3.4	9	3 Jul	--	--	50	1 Aug	81	21 Jun	12 Jul	25 Jul	6 Aug
1992	29 Jun	8.0	12	23 Jun	--	--	43	26 Jul	89	16 Jun	13 Jun	13 Jul	5 Aug
1993	26 Jun	5.3	8	24 Jun	25 Jul	4.0	22	27 Jul	44	16 Jun	9 Jul	19 Jul	27 Jul
1994	24 Jun	4.3	26	24 Jun	21 Jul	5.1	26	23 Jul	64	19 Jun	15 Jul	15 Jul	1 Aug
1995	29 Jun	5.2	49	26 Jun	29 Jul	5.2	45	30 Jul	64	21 Jun	15 Jul	21 Jul	10 Aug
1996	25 Jun	6.5	23	22 Jun	25 Jul	5.7	34	26 Jul	57	16 Jun	12 Jul	12 Jul	1 Aug
1997	27 Jun	5.1	35	25 Jun	27 Jul	5.3	50	29 Jul	84	20 Jun	15 Jul	16 Jul	8 Aug
1998	30 Jun	5.5	44	29 Jun	28 Jul	5.3	34	29 Jul	76	19 Jun	9 Jul	19 Jul	8 Aug
1999	--	not monitored			--	--	--	--	--	26 Jun	--	27 Jul	14 Aug
2000	25 Jun	7.2	30	23 Jun	25 Jul	4.8	33	22 Jul	69	18 Jun	8 Jul	17 Jul	1 Aug
2001	26 Jun	5.0	20	29 Jun	27 Jul	4.7	34	29 Jul	65	21 Jun	3 Jul	20 Jul	8 Aug
2002	25 Jun	5.0	13	27 Jun	25 Jul	4.9	30	27 Jul	50	17 Jun	10 Jul	14 Jul	8 Aug
2003	27 Jun	5.3	14	26 Jun	26 Jul	3.9	28	27 Jul	83	13 Jun	9 Jul	21 Jul	1 Aug
2004	28 Jun	3.2	22	27 Jun	27 Jul	2.9	18	27 Jul	81	19 Jun	9 Jul	23 Jul	5 Aug

[a] Hatch dates in 1976 were assumed to be the midpoint of the interval reported in Knudtson and Byrd (1982).
[b] Sample size is for the calculation of mean and median hatch dates. These dates are a subsample for which we have observations $\leq$ 7 days apart from Egg to Chick in all years except 1990; $\leq$ 10 days Egg to Chick.
[c] Sample size is for the calculation of mean and median fledge dates.
[d] The total used for estimating the remaining parameters. These dates might contain observations > 7 days, but less than 10 days apart or estimated event dates (e.g. “bird Incubating” on first visit followed by “chick” on the next visit).

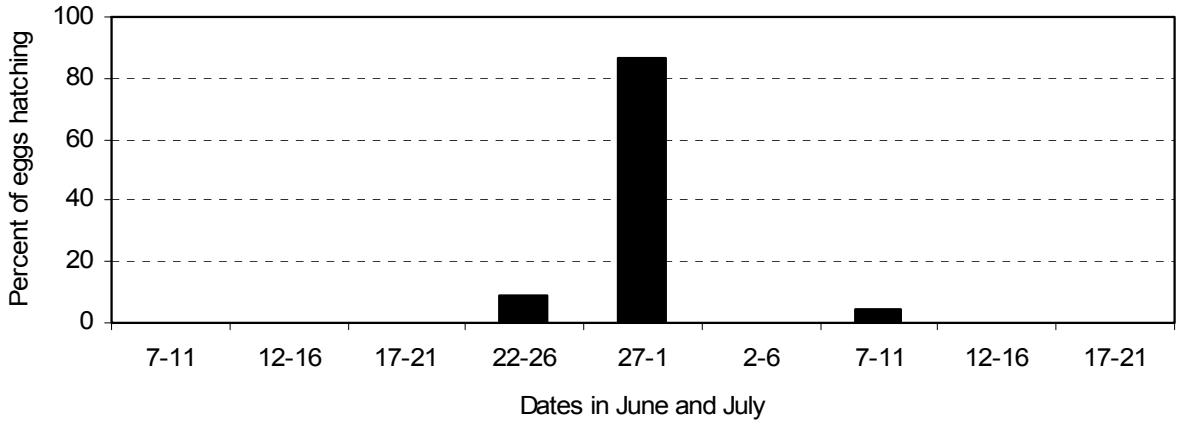

Figure 21. Hatching chronology of least auklets at Buldir Island, Alaska in 2004.

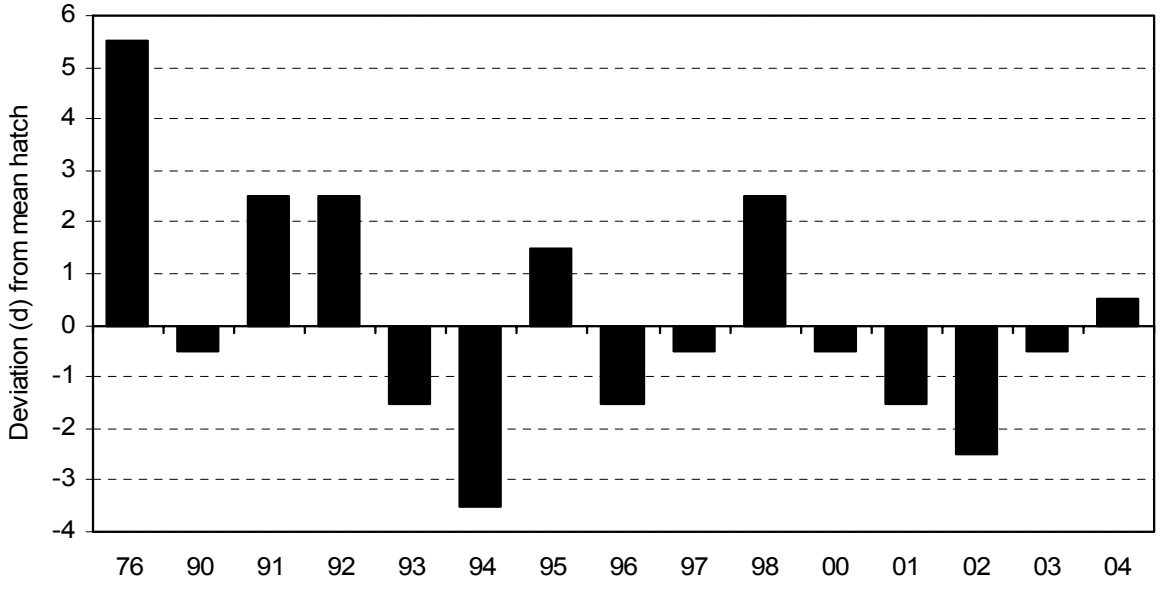

Figure 22. Yearly hatch date deviation (from the 1988-2004 average of 17 July) for least auklets at Buldir Island, Alaska. Numbers below the mean indicate hatch dates earlier, positive numbers indicate hatch dates later.

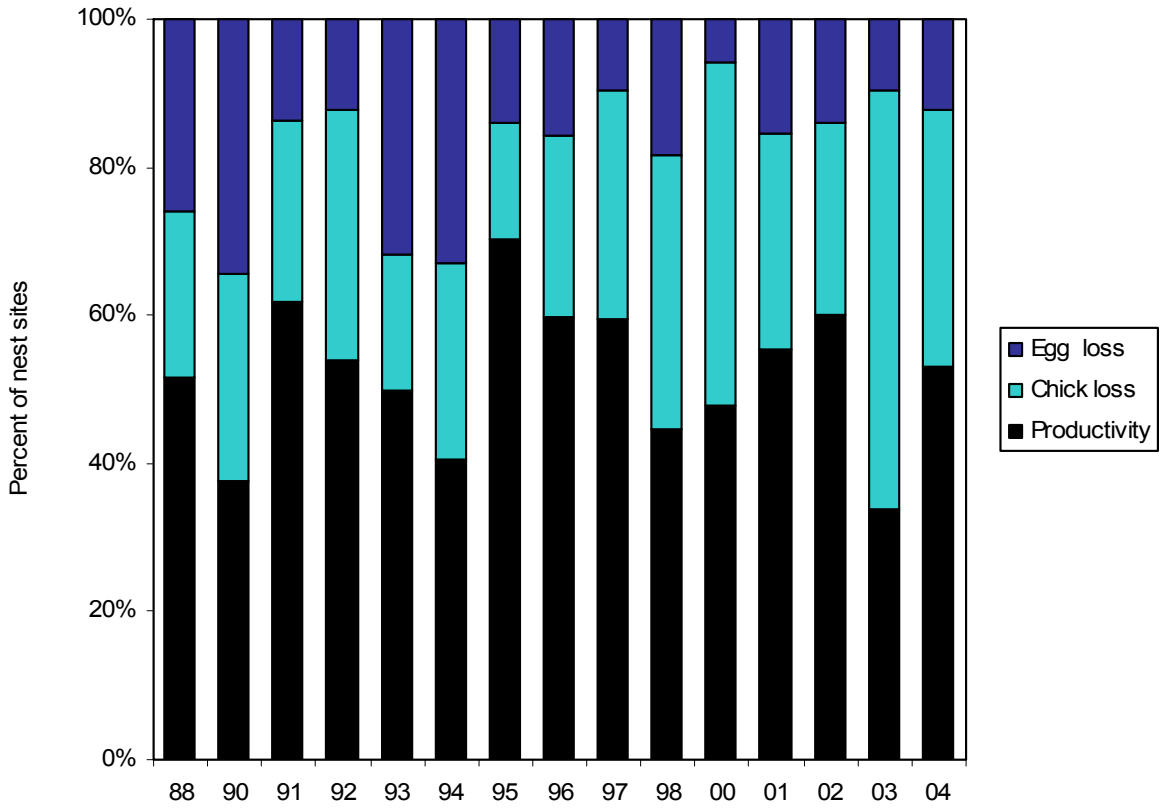

Figure 23. Reproductive performance of least auklets at Buldir Island, Alaska. Egg loss=(A-B)/A; Chick loss=(B-C)/A; Productivity=C/A, where A=number of nest sites, B=number of nest sites with a chick, C=number of sites with fledged chick.

Table 53. Reproductive performance of least auklets at Buldir Island, Alaska.

Parameter[a]	1976	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
No. eggs found (A)	28	31	60	61	81	89	44	64	64	57	84	76	0	69	65	50	83	81
No. eggs lost to:																		
disappearance	--	6	18	18	9	9	9	14	3	6	7	8	--	4	5	4	2	3
abandonment	--	0	2	2	0	1	3	6	3	1	0	6	--	0	5	3	4	4
breakage	--	2	3	1	2	1	2	1	3	2	1	0	--	0	0	0	2	3
No. eggs hatched (B)	19	23	37	40	70	78	30	43	55	48	76	62	--	65	55	43	75	71
No. chicks lost to:																		
disappearance	--	5	--	16	14	26	4	10	9	7	22	24	--	26	15	10	39	19
death	--	2	--	1	6	4	4	7	1	7	3	4	--	6	4	3	8	9
No. chicks fledged (C)	--	16	--	23	50	48	22	26	45	34	50	34	--	33	36	30	28	43
Hatching success (B/A)	0.68	0.74	0.62	0.66	0.86	0.88	0.68	0.67	0.86	0.84	0.91	0.82	--	0.94	0.85	0.86	0.90	0.88
Fledging success (C/B)[b]	--	0.70	--	0.58	0.71	0.61	0.73	0.60	0.81	0.71	0.66	0.55	--	0.51	0.65	0.70	0.37	0.61
Reproductive success (C/A)	--	0.52	--	0.38	0.62	0.54	0.50	0.41	0.70	0.60	0.60	0.45	--	0.48	0.55	0.60	0.34	0.53
Productivity (hs x fs)	--	0.52	--	0.38	0.61	0.54	0.50	0.40	0.70	0.60	0.60	0.45	--	0.48	0.55	0.60	0.33	0.54

[a] Data are from nest sites for which visit intervals at hatching and fledging were ≤ 12 days.
[b] For chicks to be considered fledged, they had to have attained the age of 25 days before disappearing or 21 days at time of last visit if chicks were still present.

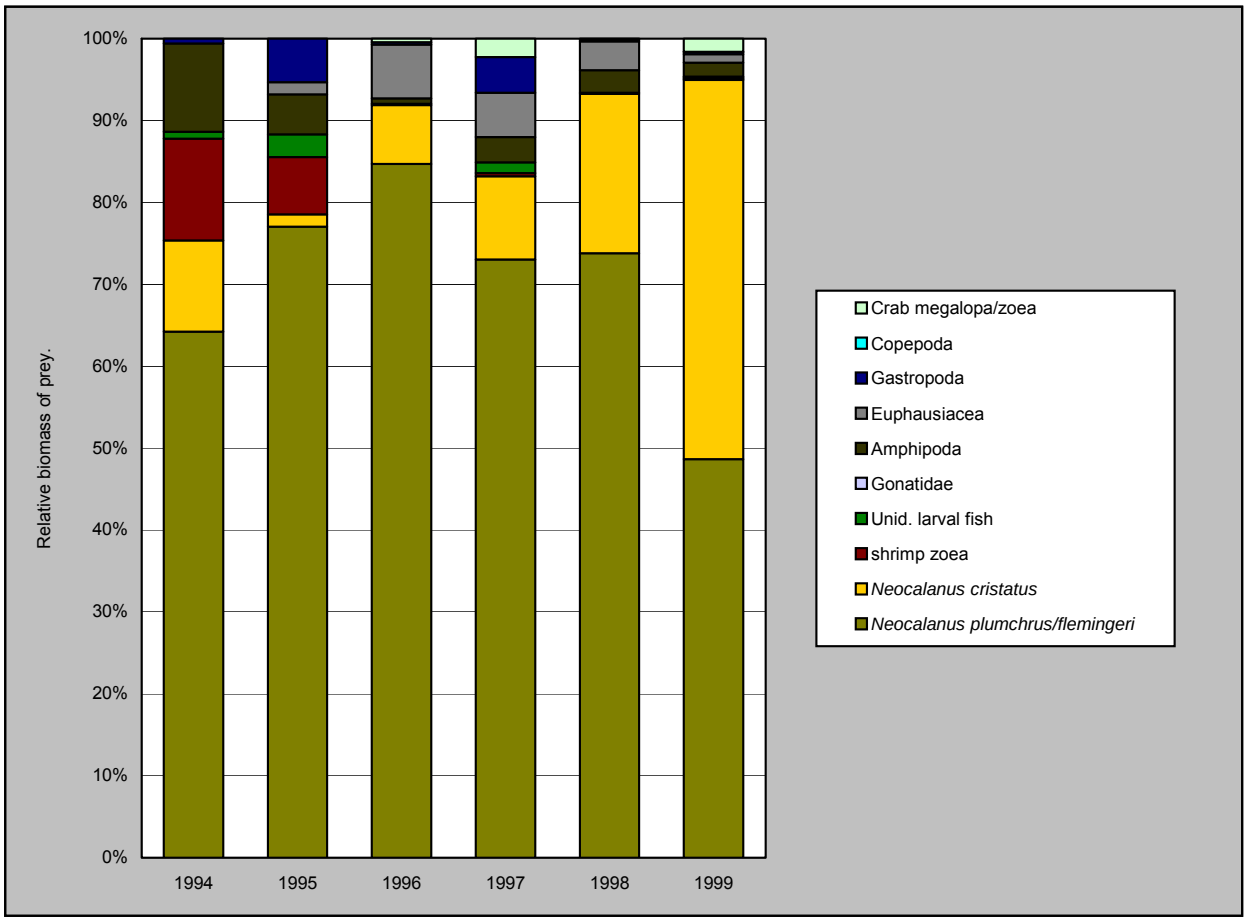

Figure 24. Relative biomass of prey in diets of least auklets at Buldir Island, Alaska.

Table 54. Relative biomass of prey in diets of least auklets at Buldir Island, Alaska. Numbers represent the percentage of the mass of combined food samples comprised by each species.

	1994	1995	1996	1997	1998	1999
No. samples	4	8	16	31	26	32
Total mass (g)	12.1	18.2	46.3	97.6	87.1	146.1
Gonatidae						0.1
Gastropoda						
Unid. snail	0.6					
Limacina helicina					0.2	
Pteropoda		5.3	0.3	4.4		0.3
Copepoda						
Neocalanus plumchrus/flemingeri	64.2	77.1	84.5	73.0	73.9	48.7
N. cristatus	11.1	1.5	7.2	10.2	19.5	46.3
Calanus marshallae					<0.1	
Pachyptilus pacificus						<0.1
Pareuchaeta birostrata						<0.1
Amphipoda						
Hyperiidea						
Hyperoche medusarum		3.6	0.1			
Parathemisto pacifica	7.5	1.3	0.6	1.2	<0.1	0.6
Primno macropa	3.3			1.8		1.1
Gammaridea						
Erichtonius spp.					2.7	
Euphausiacea						
Thysanoessa spp.		1.5	6.7	5.4		
Euphausiid furcilla					1.0	0.3
Unid. Euphausiid					2.5	0.7
Decapoda						
Shrimp zoea	12.4	7.0	0.2	0.4	0.1	0.1
Crab zoea				0.3		0.1
Crab megalopa			0.4	1.9		
Hippolytidae juvenile						1.1
Atelecyclidae megalopa					0.1	0.1
Paguridae megalopa						0.3
Fish	0.1	2.8		1.3		0.1

Table 55. Frequency of occurrence of prey in diets of least auklets at Buldir Island, Alaska. Frequency is expressed as the percentage of food samples in which each species was present.

	1994	1995	1996	1997	1998	1999
No. samples	4	8	16	31	26	32
Gonatidae						3.1
Gastropoda						
Unid. snail	50.0					
Limacina helicina					34.6	
Pteropoda		75.0	18.8	54.8		40.6
Copepoda						
Neocalanus plumchrus/flemingeri	100.0	100.0	100.0	100.0	100.0	93.8
N. cristatus	75.0	37.5	12.5	58.1	69.2	81.3
Calanus marshallae					7.7	
Pachyptilus pacificus						3.1
Pareuchaeta birostrata						3.1
Amphipoda						
Hyperiidea						
Hyperoche medusarum		50.0	12.5			
Parathemisto pacifica	75.0	50.0	31.3	19.4	11.5	31.3
Primno macropa	25.0			25.8		18.8
Gammaridea						
Erichitonius spp.					34.6	
Euphausiacea						
Thysanoessa spp.		25.0	75.0	35.5		
Euphausiid furcilla					61.5	6.3
Unid. Euphausiid					26.9	21.9
Decapoda						
Shrimp zoea	50.0	25.0	6.3	19.4	19.2	15.6
Crab zoea				3.2		3.1
Crab megalopa			6.3	22.6		
Hippolytidae megalopa						37.5
Atelecyclidae megalopa					3.8	6.3
Paguridae megalopa						6.3
Fish		25.0	12.5		6.5	3.1

Table 56. Breeding chronology dates for crested auklets at Buldir Island Alaska.

Year	mean hatch	SD	n[b]	median hatch	mean fledge	SD	n[c]	median fledge	no. nests monitored[d]	first hatch	last hatch	first fledge	last fledge
1976[a]	7 Jul	3.2	36	6 Jul	--	--	--	--	36	2 Jul	14 Jul	--	--
1990	25 Jun	5.1	12	21 Jun	--	--	26	28 Jul	68	21 Jun	19 Jul	19 Jul	>1 Aug
1991	29 Jun	5.2	6	30 Jun	--	--	43	1 Aug	74	21 Jun	12 Jul	25 Jul	8 Aug
1992	26 Jun	6.2	10	27 Jun	--	--	43	26 Jul	79	12 Jun	7 Jul	13 Jul	>10 Aug
1993	27 Jun	7.1	12	24 Jun	--	--	38	27 Jul	49	16 Jun	15 Jul	23 Jul	>31 Jul
1994	25 Jun	5.8	38	25 Jun	--	--	46	28 Jul	67	14 Jun	15 Jul	15 Jul	14 Aug
1995	29 Jun	6.7	48	26 Jun	31 Jul	4.1	51	30 Jul	66	21 Jun	21 Jul	26 Jul	16 Aug
1996	26 Jun	6.6	14	29 Jun	31 Jul	4.8	40	3 Aug	66	16 Jun	12 Jul	20 Jul	14 Aug
1997	28 Jun	6.4	11	25 Jun	--	--	62	29 Jul	82	15 Jun	15 Jul	16 Jul	8 Aug
1998	5 Jul	5.2	10	7 Jul	8 Aug	4.4	53	10 Aug	70	20 Jun	21 Jul	27 Jul	18 Aug
1999	--	not monitored			--	--	--	--	--	26 Jun	23 Jul	27 Jul	19 Aug
2000	29 Jun	3.6	19	27 Jun	1 Aug	3.7	48	1 Aug	78	23 Jun	8 Jul	22 Jul	7 Aug
2001	29 Jun	4.6	16	28 Jun	31 Jul	4.0	42	29 Jul	75	22 Jun	2 Jul	23 Jul	8 Aug
2002	25 Jun	4.9	26	25 Jun	30 Jul	5.3	49	31 Jul	81	17 Jun	5 Jul	14 Jul	8 Aug
2003	2 Jul	4.6	9	4 July	31 Jul	5.5	6	1 Aug	45	23 Jun	<18 Jul	21 Jul	7 Aug
2004	5 Jul	4.7	17	7 Jul	7 Aug	4.3	7	10 Aug	67	22 Jun	17 Jul	27 Jul	10 Aug

[a] Hatch dates in 1976 were assumed to be the midpoint of the interval reported in Knudtson and Byrd (1982).
[b] Sample size is for the calculation of mean and median hatch dates. These dates are a subsample for which we have observations $\leq$ 7 days apart from Egg to Chick in all years except 1990: $\leq$ 10 days Egg to Chick and 1992: $\leq$ 8 days Egg to Chick.
[c] Sample size is for the calculation of mean and median fledge dates.
[d] The total used for estimating the remaining parameters. These dates might contain observations > 7, but less than 10 days apart or estimated event dates (e.g. “bird incubating” on first visit followed by “chick” on the next visit).

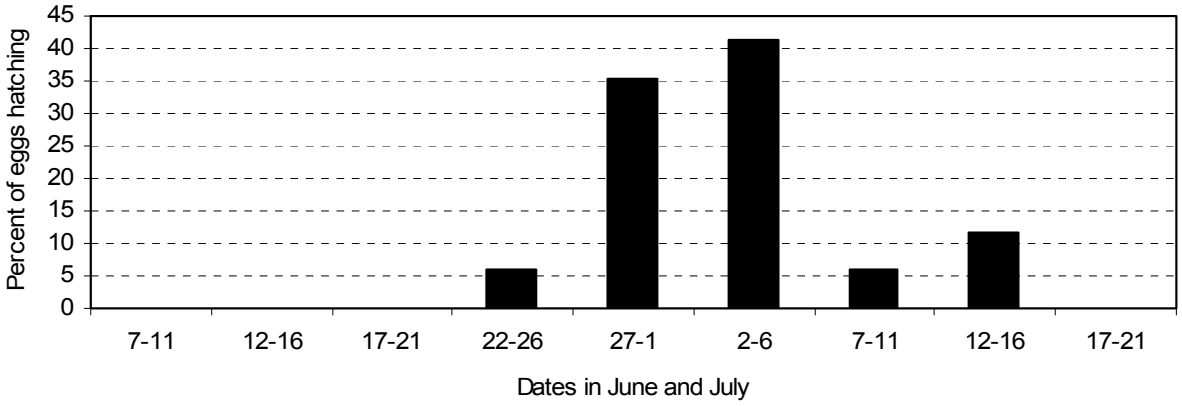

Figure 25. Hatching chronology of crested auklets at Buldir Island, Alaska in 2004.

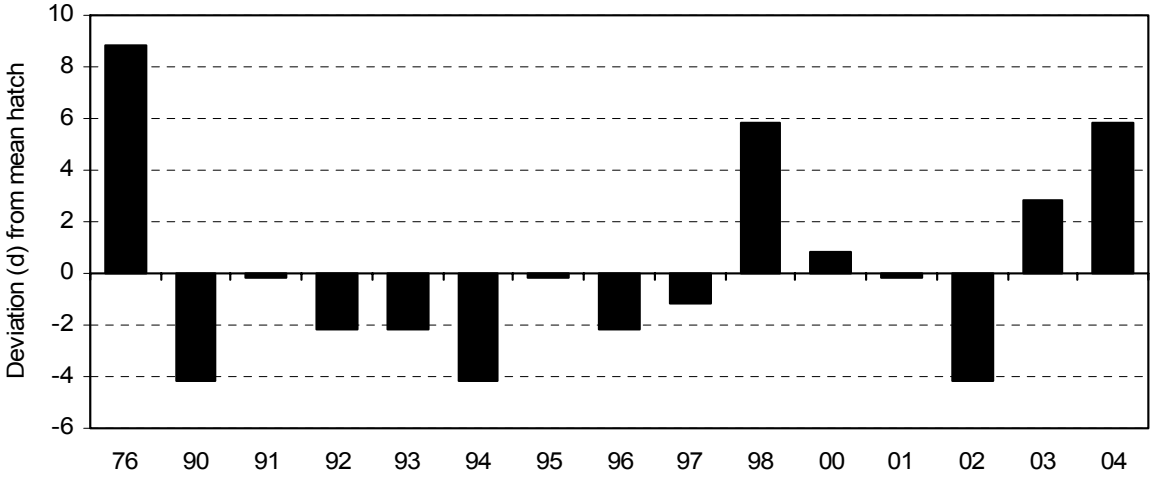

Figure 26. Yearly hatch date deviation (from the 1988-2004 average of 17 July) of crested auklets at Buldir Island, Alaska. Numbers below the mean indicate hatch dates earlier; positive numbers indicate hatch dates later.

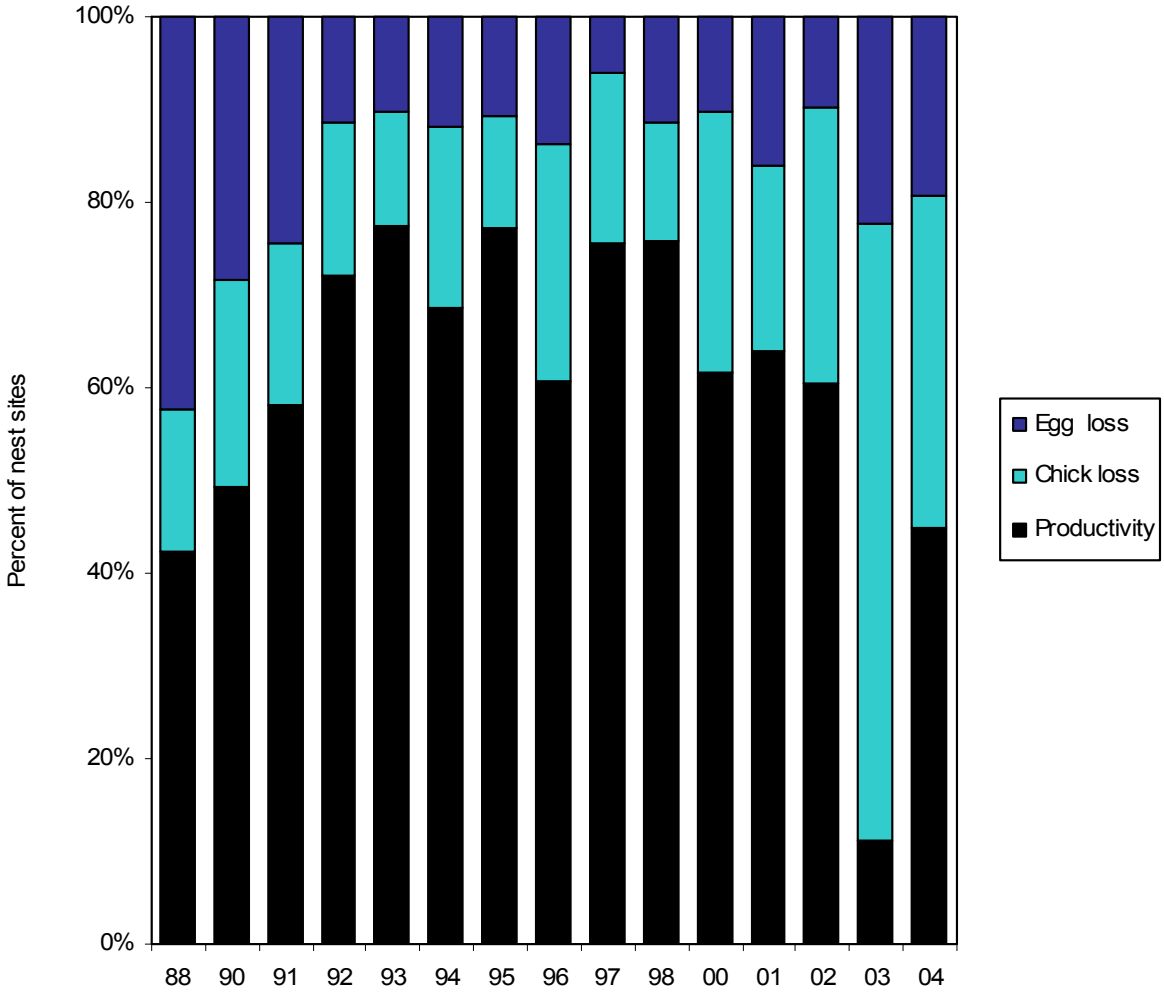

Figure 27. Reproductive performance of crested auklets at Buldir Island, Alaska. Egg loss=(A-B)/A; Chick loss=(B-C)/A; Productivity=C/A, where A=number of nest sites, B=number of nest sites with a chick, C=number of sites with fledged chick.

Table 57. Reproductive performance of crested auklets at Buldir Island, Alaska.

Parameter[a]	1976	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
No. eggs found (A)	59	33	83	67	74	79	49	67	66	66	82	70	0	78	75	81	45	67
No. eggs lost to:																		
disappearance	--	4	23	15	13	7	3	4	5	7	2	4	--	6	6	3	4	6
abandonment	--	9	4	3	3	2	2	2	1	2	2	4	--	1	6	5	6	5
breakage	--	1	3	1	2	0	0	2	1	0	1	0	--	1	0	0	0	2
No. eggs hatched (B)	45	19	53	48	56	70	44	59	59	57	77	62	--	70	63	73	35	54
No. chicks lost to:																		
disappearance	--	1	--	13	12	12	6	9	7	9	14	9	--	17	8	16	14	13
death	--	4	--	2	1	1	0	4	1	8	1	0	--	5	7	8	16	11
No. chicks fledged (C)	--	14	--	33	43	57	38	46	51	40	62	53	--	48	48	49	5	30
Hatching success (B/A)	0.76	0.58	0.64	0.72	0.76	0.87	0.90	0.88	0.89	0.86	0.94	0.89	--	0.90	0.84	0.90	0.78	0.81
Fledging success (C/B)[b]	--	0.74	--	0.69	0.77	0.81	0.86	0.78	0.86	0.70	0.81	0.85	--	0.69	0.76	0.67	0.14	0.56
Reproductive success (C/A)	--	0.42	--	0.49	0.58	0.72	0.78	0.69	0.77	0.61	0.76	0.76	--	0.62	0.64	0.60	0.11	0.45
Productivity (hs x fs)	--	0.42	--	0.49	0.59	0.70	0.78	0.69	0.77	0.60	0.76	0.76	--	0.62	0.64	0.60	0.11	0.45

[a] Data are from nest sites for which visit intervals at hatching and fledging were $\leq$ 12 days.
[b] For chicks to be considered fledged, they had to have attained the age of 26 days before disappearing or 22 days at time of last visit if chicks were still present.

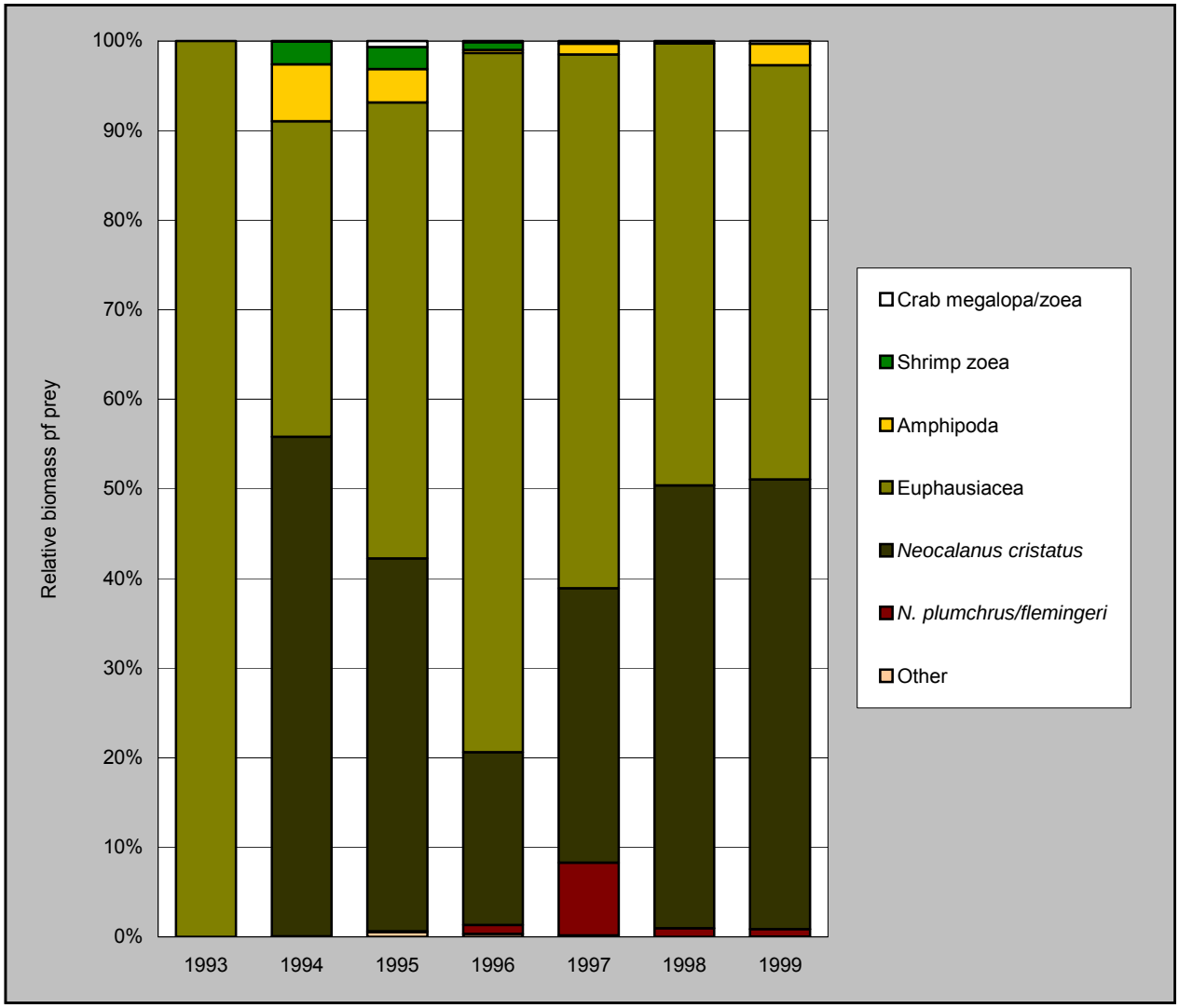

Figure 28. Relative biomass of prey in diets of crested auklets at Buldir Island, Alaska.

Table 58. Relative biomass of prey in diets of crested auklets at Buldir Island, Alaska. Numbers represent the percentage of the mass of combined food samples comprised by each species.

	1993	1994	1995	1996	1997	1998	1999
No. samples	1	37	47	78	82	103	88
Total mass (g)	1.2	335.4	487.6	745.0	904.7	1102.9	908.6
Pteropoda				<0.1			
Cephalopoda - squid			0.2	0.1	<0.1	<0.1	
Copepoda							
Neocalanus plumchrus/flemingeri		0.1	0.1	1.0	8.1	1.0	7.5
N. cristatus		55.8	41.6	19.3	30.7	49.5	50.2
Amphipoda							
Hyperiidea							
Hyperoche medusarum				<0.1			
Parathemisto pacifica		5.6	3.7	0.3	1.2	0.3	2.3
Primno macropa		0.7					0.1
Euphausiacea							
Thysanoessa spp.	100.0	35.2	50.9	78.1	59.6		
Unid. Euphausiid						49.3	46.2
Euphausiid furcilla							<0.1
Decapoda							
Shrimp zoea		2.6	2.5	0.9	0.1	<0.1	
Crab zoea		<0.1	0.7		<0.1	<0.1	0.1
Crab megalopa				0.1	0.2		
Paguridae megalopa							<0.1
Hippolytidae juvenile							0.1
Fish		0.3	0.2	0.1		<0.1	<0.1

Table 59. Frequency of occurrence of prey in diets of crested auklets at Buldir Island, Alaska. Frequency is expressed as the percentage of food samples in which each species was present.

	1993	1994	1995	1996	1997	1998	1999
No. samples	1	37	47	78	82	103	88
Pteropoda				1.3			
Cephalopoda - squid			4.3	1.3	2.2	1.0	
Copepoda							
Neocalanus plumchrus/flemingeri		16.2	6.4	17.9	39.6	45.6	15.9
N. cristatus		91.9	78.7	34.6	63.0	94.2	92.0
Amphipoda							
Hyperiidea							
Hyperoche medusarum				2.6			
Parathemisto pacifica		43.2	51.1	32.1	50.3	36.9	37.5
Primno macropa		21.6					1.1
Euphausiacea							
Thysanoessa spp.	100.0	89.2	72.3	94.9	77.6		
Unid. Euphausiid						90.3	97.7
Euphausiid furcilla							1.1
Decapoda							
Shrimp zoea		13.5	25.5	25.6	6.9	5.8	
Crab zoea		2.7	4.3		3.4	1.0	5.7
Crab megalopa				9.0	9.1		
Paguridae megalopa							1.1
Hippolytidae juvenile							8.0
Fish		8.5	3.8	4.2		3.9	2.3
(Nematodes - probably not prey)					28.3		

Table 60. Breeding chronology dates for whiskered auklets at Buldir Island Alaska.

Year	mean hatch	SD	n[b]	median hatch	mean fledge	SD	n[c]	median fledge	no. nests monitored[d]	first hatch	last hatch	first fledge	last fledge
1976[a]	30 Jun	4.6	6	27 Jun	--	--	--	--	7	27 Jun	6 Jul	--	--
1990	24 Jun	5.4	5	20 Jun	--	--	5	28 Jul	9	10 Jun	30 Jun	18 Jul	27 Jul
1991	27 Jun	3.6	9	26 Jun	3 Aug	4.2	23	4 Aug	46	18 Jun	8 Jul	24 Jul	8 Aug
1992	18 Jun	10.7	10	14 Jun	--	--	33	26 Jul	58	10 Jun	5 Jul	13 Jul	5 Aug
1993	22 Jun	8.2	13	19 Jun	--	--	31	27 Jul	54	13 Jun	9 Jul	15 Jul	12 Aug
1994	19 Jun	7.6	37	17 Jun	--	--	44	23 Jul	57	9 Jun	8 Jul	15 Jul	14 Aug
1995	25 Jun	6.3	50	21 Jun	--	--	45	30 Jul	68	15 Jun	25 Jul	21 Jul	16 Aug
1996	22 Jun	9.8	27	19 Jun	--	--	40	26 Jul	57	10 Jun	20 Jul	20 Jul	14 Aug
1997	24 Jun	7.9	33	21 Jun	30 Jul	5.9	59	29 Jul	90	11 Jun	18 Jul	24 Jul	14 Aug
1998	23 Jun	9.8	61	19 Jun	31 Jul	9.3	41	29 Jul	78	9 Jun	11 Jul	19 Jul	27 Aug
1999	--	not monitored		--	--	--	--	--	--	--	22 Jul	22 Jul	13 Aug
2000	16 Jun	5.2	27	18 Jun	25 Jul	6.3	32	27 Jul	70	6 Jun	13 Jul	17 Jul	13 Aug
2001	22 Jun	6.2	36	20 Jun	28 Jul	4.2	26	29 Jul	75	9 Jun	15 Jul	15 Jul	2 Aug
2002	24 Jun	8.5	36	21 Jun	29 Jul	5.4	48	27 Jul	100	15 Jun	15 Jul	21 Jul	14 Aug
2003	25 Jun	2.9	4	25 Jun	30 Jul	7.1	25	1 Aug	44	9 Jun	4 Jul	15 Jul	12 Aug
2004	21 Jun	4.7	28	21 Jun	28 Jul	3.7	17	30 Jul	66	16 Jun	12 Jul	22 Jul	4 Aug

[a] Hatch dates in 1976 were assumed to be the midpoint of the interval reported in Knudtson and Byrd (1982).
[b] Sample size is for the calculation of mean and median hatch dates. These dates are a subsample for which we have observations ≤ 7 days apart from Egg to Chick in all years except 1990: $\leq$ 10 days Egg to Chick.
[c] Sample size is for the calculation of mean and median fledge dates.
[d] The total used for estimating the remaining parameters. These dates might contain observations > 7, but less than 10 days apart or estimated event dates (e.g. “bird Incubating” on first visit followed by “chick” on the next visit).

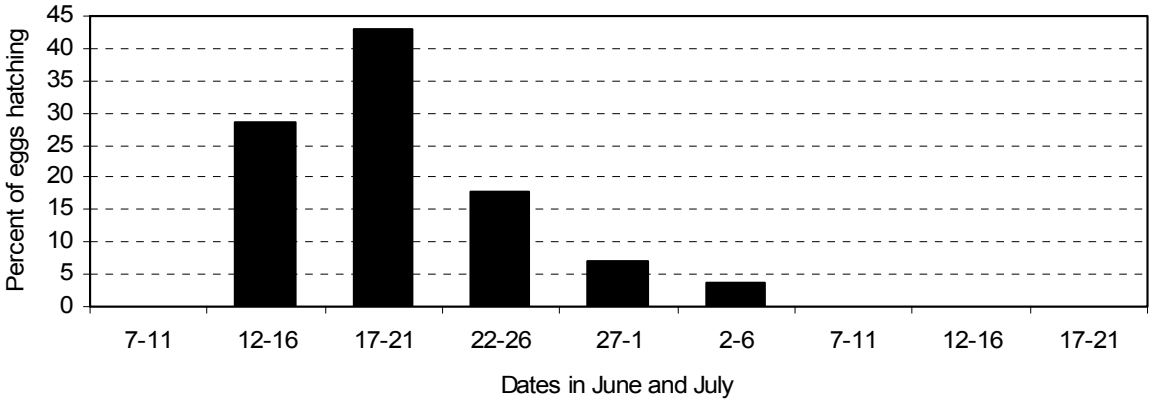

Figure 29. Hatching chronology of whiskered auklets at Buldir Island, Alaska in 2004.

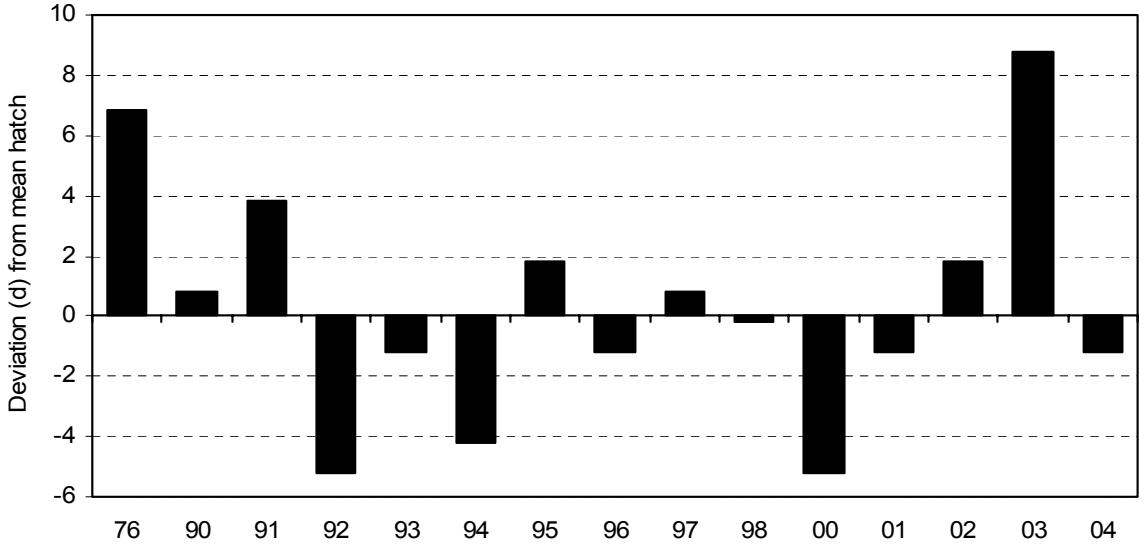

Figure 30. Yearly hatch date deviation (from the 1988-2004 average of 17 July) of whiskered auklets at Buldir Island, Alaska. Numbers below the mean indicate hatch dates earlier; positive numbers indicate hatch dates later.

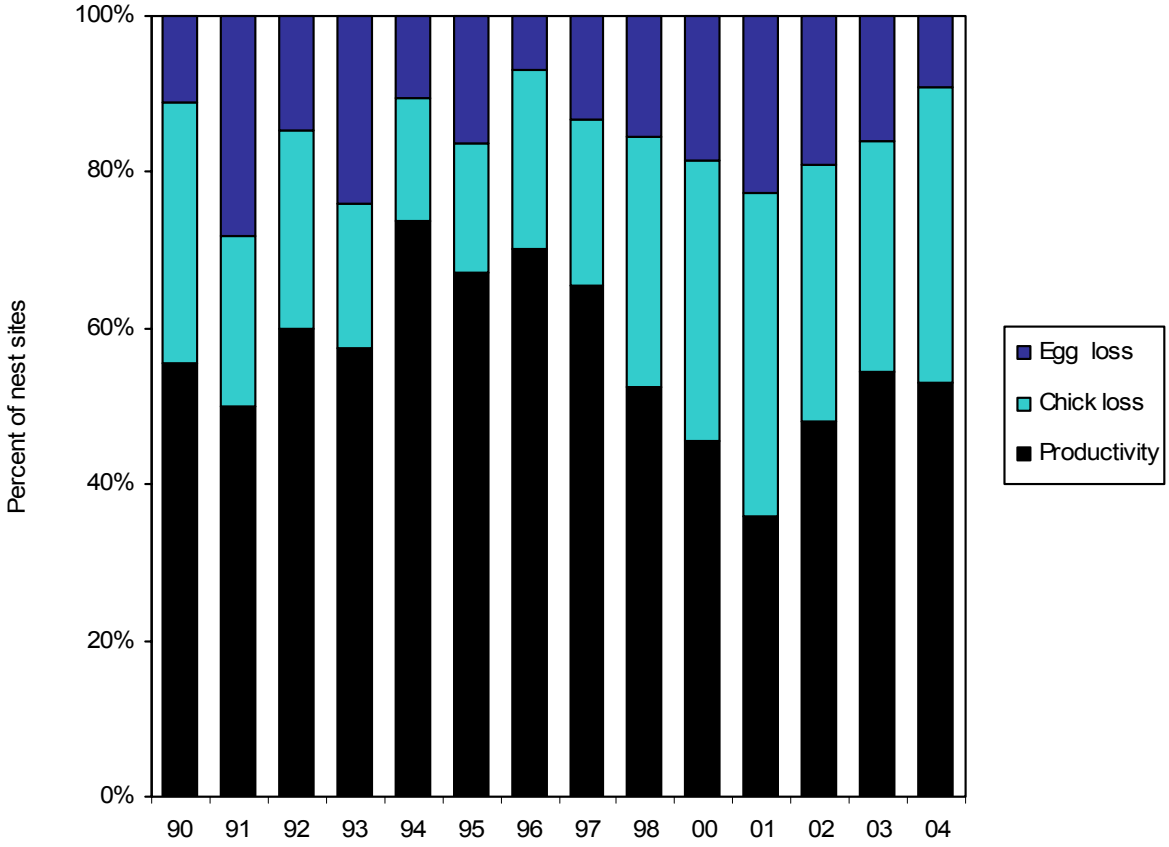

Figure 31. Reproductive performance of whiskered auklets at Buldir Island, Alaska. Egg loss=(A-B)/A; Chick loss=(B-C)/A; Productivity=C/A, where A=number of nest sites, B=number of nest sites with a chick, C=number of sites with fledged chick.

Table 61. Reproductive performance of whiskered auklets at Buldir Island, Alaska.

Parameter[a]		1976	1988	1989	1990	1991	1992	1993	1994	1995
No. eggs found (A)		7	7	16	9	46	55	54	57	67
No. eggs lost to:	disappearance	-	0	1	1	5	5	8	4	2
	breakage	-	0	2	0	4	3	4[b]	2	9
	abandonment	-	0	2	0	4	0	1	0	0
No. eggs hatched (B)		6	7	11	8	33	47	41	51	56
No. chicks lost to:	disappearance	-	-	-	2	7	9	6	6	10
	death	-	-	-	1	3	5	4	3	1
No. chicks fledged (C)		-	-	-	5	23	33	31	42	45
Hatching success (B/A)		0.86	1.00	0.69	0.89	0.72	0.85	0.76	0.89	0.84
Fledging success (C/B)[b]		-	-	-	0.63	0.70	0.70	0.76	0.82	0.80
Productivity (hs x fs)		-	-	-	0.56	0.50	0.60	0.57	0.74	0.67
Reproductive success (C/A)		-	-	-	0.56	0.50	0.60	0.58	0.73	0.67

[a] Data are from nest sites for which visit intervals at hatching and fledging were $\leq$ 12 days.
[b] For chicks to be considered fledged, they had to have attained the age of 32 days before disappearing or 29 days at time of last visit, if chicks were still present.

Table 61 continued. Reproductive performance of whiskered auklets at Buldir Island, Alaska.

Parameter[a]		1996	1997	1998	1999	2000	2001	2002	2003	2004
No. eggs found (A)		57	90	78	0	70	75	100	44	66
No. eggs lost to:	disappearance	1	8	9	-	4	5	6	3	3
	breakage	3	3	2	-	9	12	10	4	2
	abandonment	0	1	1	-	0	0	3	0	1
No. eggs hatched (B)		53	78	66	-	57	58	81	37	60
No. chicks lost to:	disappearance	6	17	20	-	20	5	21	9	12
	death	7	2	5	-	5	26	12	4	13
No. chicks fledged (C)		40	59	41	-	32	27	48	24	35
Hatching success (B/A)		0.93	0.87	0.85	-	0.81	0.77	0.81	0.84	0.91
Fledging success (C/B)[b]		0.75	0.76	0.62	-	0.56	0.47	0.59	0.65	0.58
Productivity (hs x fs)		0.70	0.66	0.53	-	0.46	0.36	0.48	0.55	0.53
Reproductive success (C/A)		0.70	0.66	0.53	-	0.46	0.36	0.48	0.55	0.53

[a] Data are from nest sites for which visit intervals at hatching and fledging were $\leq$ 12 days.
[b] For chicks to be considered fledged, they had to have attained the age of 32 days before disappearing or 29 days at time of last visit, if chicks were still present.

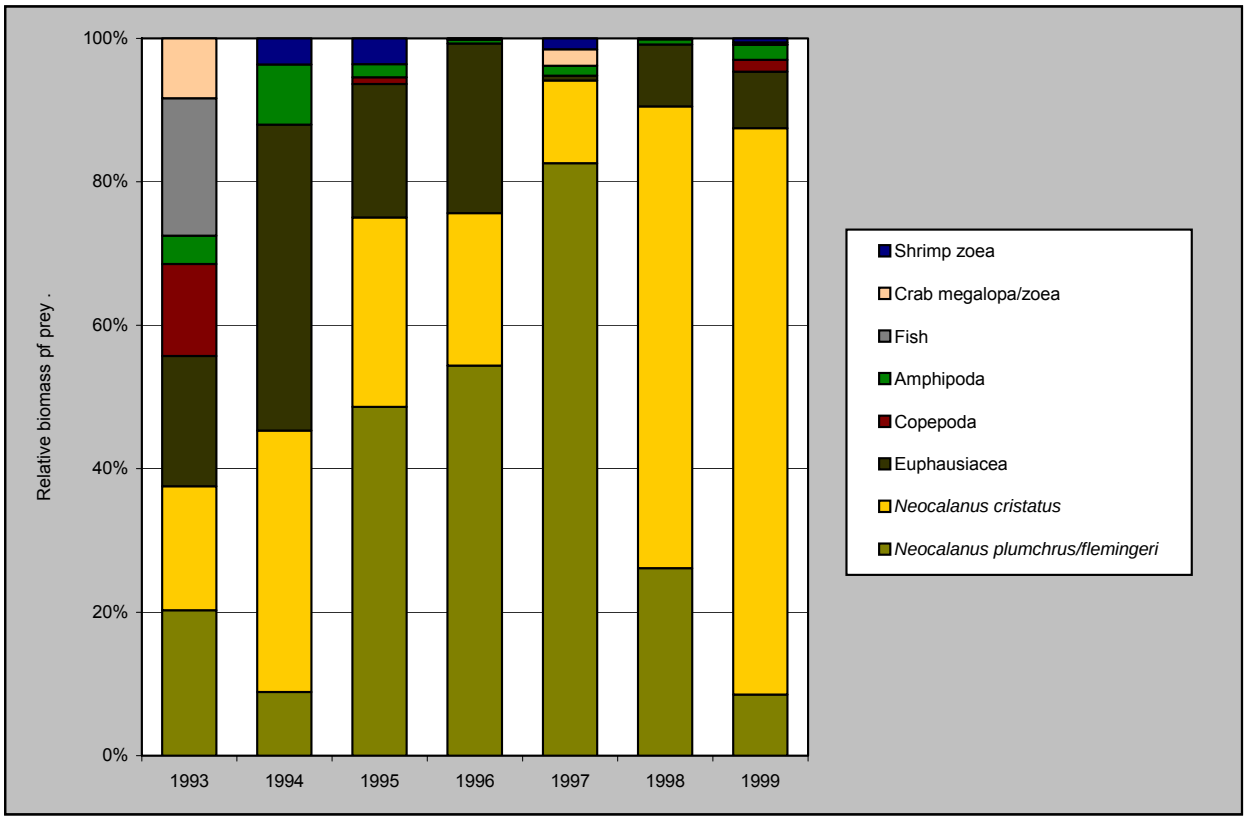

Figure 32. Relative biomass of prey in diets of whiskered auklets at Buldir Island, Alaska.

Table 62. Relative biomass of prey in diets of whiskered auklets at Buldir Island, Alaska. Numbers represent the percentage of the mass of combined food samples comprised by each species.

	1993	1994	1995	1996	1997	1998	1999
No. samples	24	16	48	71	36	26	43
Total mass (g)	53.4	93.9	387.5	481.3	300.2	214.1	434.1
Gastropoda							
Unid. snail		0.2					
Pteropoda – (prob. *Limacina helicina)*	1.5		0.7	0.3	2.1	0.2	0.2
Copepoda							
Neocalanus plumchrus/flemingeri	21.8	8.9	48.3	54.2	80.9	26.1	8.5
N. cristatus	18.6	36.4	26.2	21.2	11.3	64.3	78.8
Calanus pacifica			0.1				
Pachyptilus pacificus							1.0
Pareuchta birostrata							0.7
Lophotrix frontalis							<0.1
Unid. Copepoda	13.8		0.9				
Amphipoda							
Hyperiidea							
Hyperoche medusarum			1.7	0.5			
Parathemisto pacifica	3.9	0.5	0.1	<0.1	<0.1		
Primno macropa	0.3	7.9			1.3	0.7	2.1
Gammaridea							
Talitridae				0.1			
Euphausiacea							
Thysanoessa spp.	19.5	42.5	18.5	23.6	0.6		
Unid. Euphausiid						8.4	7.9
Euphausiid furcilla						0.2	
Decapoda							
Shrimp zoea		3.6	3.6	0.1	1.5	0.1	0.6
Crab zoea				<0.1	0.6		
Crab megalopa				0.1	1.6		
Hippolytidae juvenile							0.3
Fish - *Hexagrammos* spp.	20.6						0.2

Table 63. Frequency of occurrence of prey in diets of whiskered auklets at Buldir Island, Alaska. Frequency is expressed as the percentage of food samples in which each species was present.

Sample	1993	1994	1995	1996	1997	1998	1999
Number	24	16	48	71	36	26	43
Scyphozoa				1.4			
Gastropoda							
Unid. snail		25.0					
Pteropoda – (prob. *Limacina helicina)*	4.2		39.6	50.7	66.7	34.6	44.2
Copepoda							
Neocalanus plumchrus/flemingeri	62.5	93.8	93.8	97.2	100.0	88.5	83.7
N. cristatus	45.8	100.0	93.8	74.6	75.0	96.2	97.7
Calanus pacifica			4.2				
Pachyptilus pacifica							14.0
Pareuchta birostrata							18.6
Lophotrix frontinalis							2.3
Unid. Copepoda	20.8		2.1				
Amphipoda							
Hyperiidea							
Hyperoche medusarum			31.3	62.0			
Parathemisto pacifica	16.7	12.5	6.3	2.8	2.8		
Primno macropa	4.2	68.8			36.1	15.4	41.9
Gammaridea							
Talitridae				4.2			
Euphausiacea							
Thysanoessa spp.	91.7	68.8	66.7	87.3	8.3		
Unid. Euphausiid						92.3	90.7
Euphausiid furcilla						19.2	
Decapoda							
Shrimp zoea		25.0	29.2	12.7	58.3	34.6	60.5
Crab zoea				9.9	16.7		
Crab megalopa				5.6	22.2		
Hippolytidae juvenile							16.3
Fish							
Hexagrammos spp.	4.2						
Unid. fish			6.3				2.3
(Plastic - not prey)	4.2						

Table 64. Breeding chronology dates for parakeet auklets at Buldir Island Alaska.

Year	mean hatch	SD	n[a]	median hatch	mean fledge	SD	n[b]	median fledge	no. nests monitored[c]	first hatch	last hatch	first fledge	last fledge
1991	5 Jul	5.5	14	5 Jul	--	--	27	9 Aug	53	30 Jun	9 Jul	3 Aug	>14 Aug
1992	5 Jul	6.8	8	4 Jul	--	--	28	4 Aug	43	25 Jun	15 Jul	27 Jul	>12 Aug
1993	4 Jul	7.9	12	1 Jul	--	--	17	4 Aug	35	19 Jun	15 Jul	27 Jul	10 Aug
1994	1 Jul	5.7	37	1 Jul	--	--	33	5 Aug	65	20 Jun	15 Jul	23 Jul	22 Aug
1995	5 Jul	6.1	37	3 Jul	--	--	49	6 Aug	70	21 Jun	17 Jul	30 Jul	>17 Aug
1996	3 Jul	5.0	31	4 Jul	--	--	38	11 Aug	64	16 Jun	20 Jul	26 Jul	14 Aug
1997	3 Jul	5.1	22	1 Jul	7 Aug	5.7	30	6 Aug	62	26 Jun	13 Jul	27 Jul	16 Aug
1998	14 Jul	6.3	34	14 Jul	--	--	43	16 Aug	71	29 Jun	31 Jul	10 Aug	>27 Aug
1999	--	--	--	--	--	--	--	not monitored	--	--	--	--	--
2000	28 Jun	6.6	22	27 Jun	1 Aug	4.7	29	2 Aug	65	12 Jun	14 Jul	23 Jul	13 Aug
2001	27 Jun	2.7	9	29 Jun	none	--	--	n/a	40	22 Jun	29 Jun	n/a	n/a
2002	5 Jul	4.9	19	5 Jul	1 Aug	8.6	7	2 Aug	55	27 Jun	22 Jul	29 Jul	12 Aug
2003	6 Jul	7.0	6	4 Jul	8 Aug	7.7	15	6 Aug	34	19 Jun	19 Jul	25 Jul	18 Aug
2004	3 Jul	5.4	12	4 Jul	8 Aug	3.4	4	9 Aug	37	24 Jun	14 Jul	4 Aug	11 Aug

[a] Sample size is for the calculation of mean and median hatch dates. These dates are a subsample for which we have observations ≤ 7 days apart from Egg to Chick in all years except 1991: ≤ 9 days egg to Chick, and 1993: ≤ 9 days "egg" to "chick" or "bird incubating" to "chick".

[b] Sample size is for the calculation of mean and median fledge dates.

[c] The total used for estimating the remaining parameters. These dates might contain observations > 7, but < 10 days apart or estimated event dates (e.g. "bird incubating" on first visit followed by "chick" on the next visit).

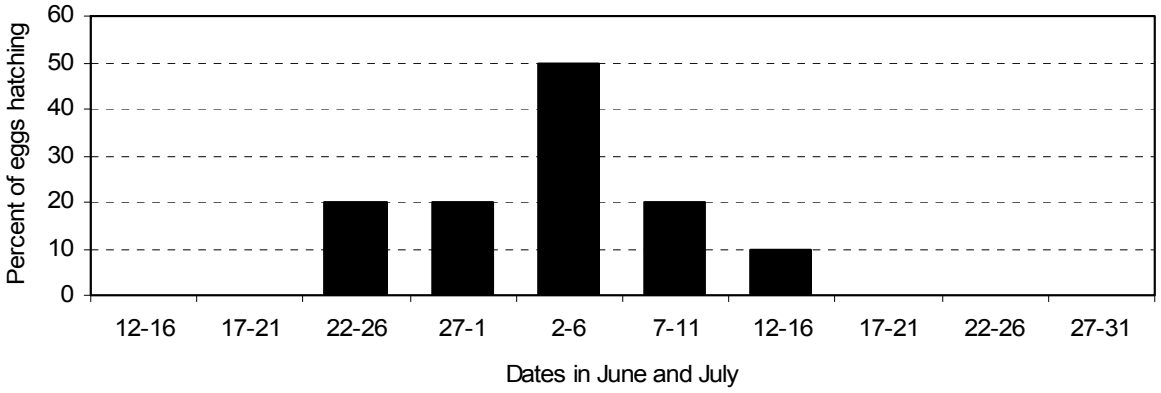

Figure 33. Hatching chronology of parakeet auklets at Buldir Island, Alaska in 2004.

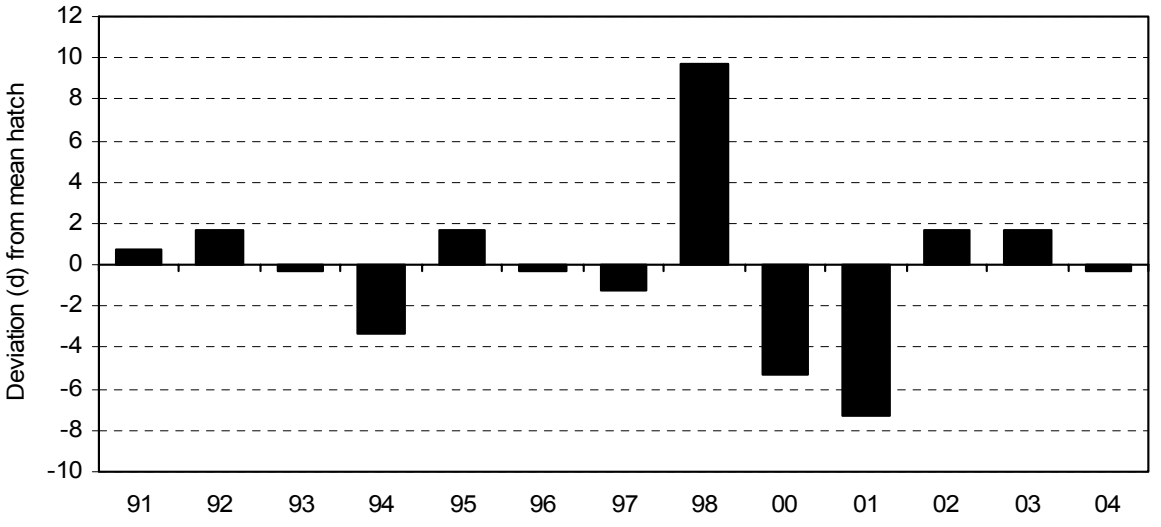

Figure 34. Yearly hatch date deviation (from the 1988-2004 average of 17 July) of parakeet auklets at Buldir Island, Alaska. Numbers below the mean indicate hatch dates earlier; positive numbers indicate hatch dates later.

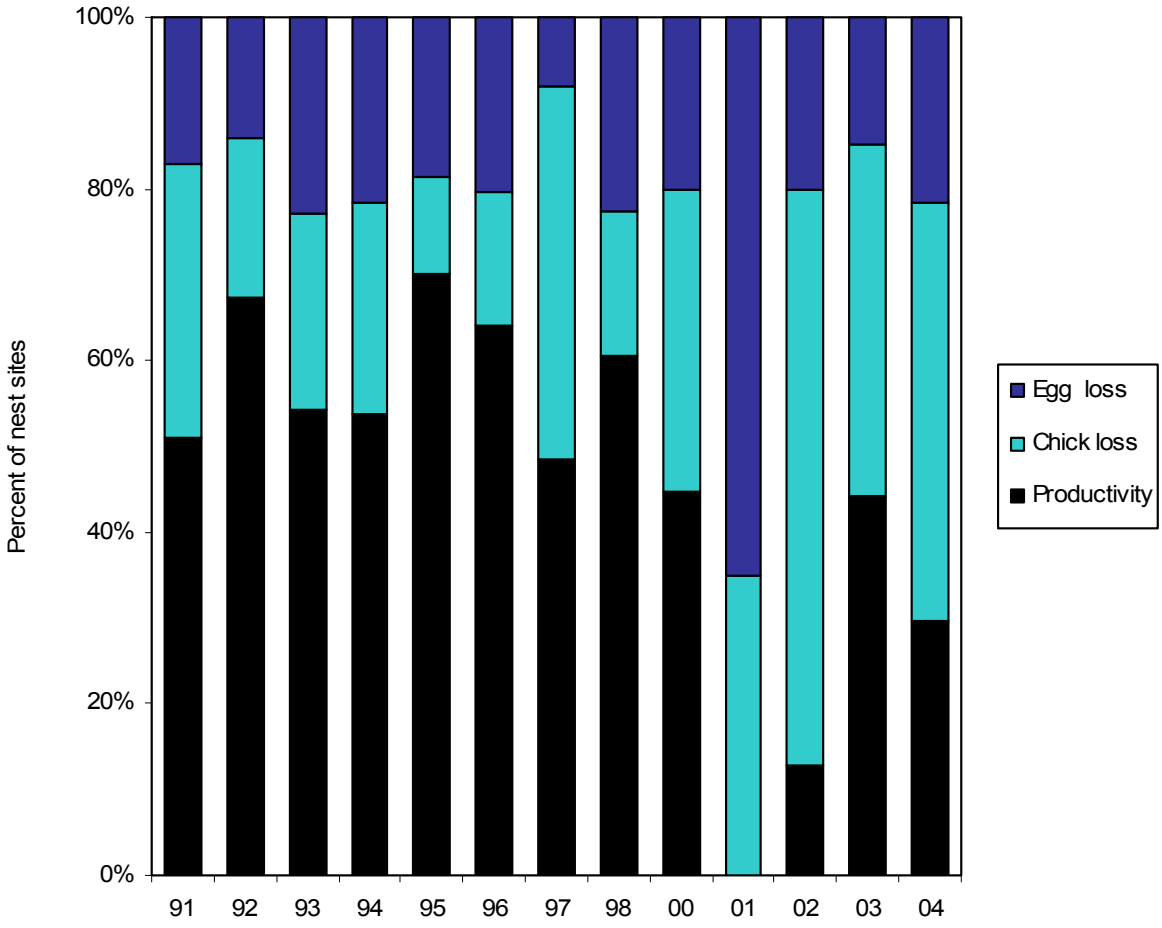

Figure 35. Reproductive performance of parakeet auklets at Buldir Island, Alaska. Egg loss=(A-B)/A; Chick loss=(B-C)/A; Productivity=C/A, where A=number of nest sites, B=number of nest sites with a chick, C=number of sites with fledged chick.

Table 65. Reproductive performance of parakeet auklets at Buldir Island, Alaska.

Parameter[a]		1991	1992	1993	1994	1995	1996	1997
No. eggs found (A)		53	43	35	65	70	64	62
No. eggs lost to:	disappearance	2	3	4	6	5	9	1
	breakage	3	3	3	6	6	3[b]	2
	abandonment	4	0	1	2	2	1	2
No. eggs hatched (B)		44	37	27	51	57	51	57
No. chicks lost to:	disappearance	8	6	7	12	8	2	9
	death	9	2	1	4	0	8	18
No. chicks fledged (C)		27	29	19	35	49	41	30
Hatching success (B/A)		0.83	0.86	0.77	0.78	0.81	0.80	0.92
Fledging success (C/B)[c]		0.61	0.78	0.70	0.69	0.86	0.80	0.53
Productivity (hs x fs)		0.51	0.67	0.54	0.54	0.70	0.64	0.48
Reproductive success (C/A)		0.51	0.67	0.54	0.54	0.70	0.64	0.49

[a] Data are from nest sites for which visit intervals at hatching and fledging were $\leq$ 12 days.
[b] Two of these nest sites were taken over by horned puffins.
[c] For chicks to be considered fledged, they had to have attained 30 days of age before disappearing or 26 days at the time of the last visit, if chicks were still present.

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Table 65 continued. Reproductive performance of parakeet auklets at Buldir Island, Alaska.

Parameter[a]		1998	1999	2000	2001	2002	2003	2004
No. eggs found (A)		71	0	65	40	55	34	37
No. eggs lost to:	disappearance	11	-	10	8	6	0	3
	breakage	5	-	3	18	5	5	3
	abandonment	0	-	0	0	0	0	2
No. eggs hatched (B)		55	-	52	14	44	29	29
No. chicks lost to:	disappearance	0	-	22	3	6	10	6
	death	12	-	1	11	27	4	12
No. chicks fledged (C)		43	-	29	0	7	15	11
Hatching success (B/A)		0.77	-	0.80	0.35	0.80	0.85	0.78
Fledging success (C/B)[c]		0.78	-	0.56	0.00	0.16	0.52	0.38
Productivity (hs x fs)		0.61	-	0.45	0.00	0.13	0.44	0.30
Reproductive success (C/A)		0.60	-	0.45	0.00	0.13	0.44	0.30

[a] Data are from nest sites for which visit intervals at hatching and fledging were $\leq$ 12 days.
[b] Two of these nest sites were taken over by horned puffins.
[c] For chicks to be considered fledged, they had to have attained 30 days of age before disappearing or 26 days at the time of the last visit, if chicks were still present.

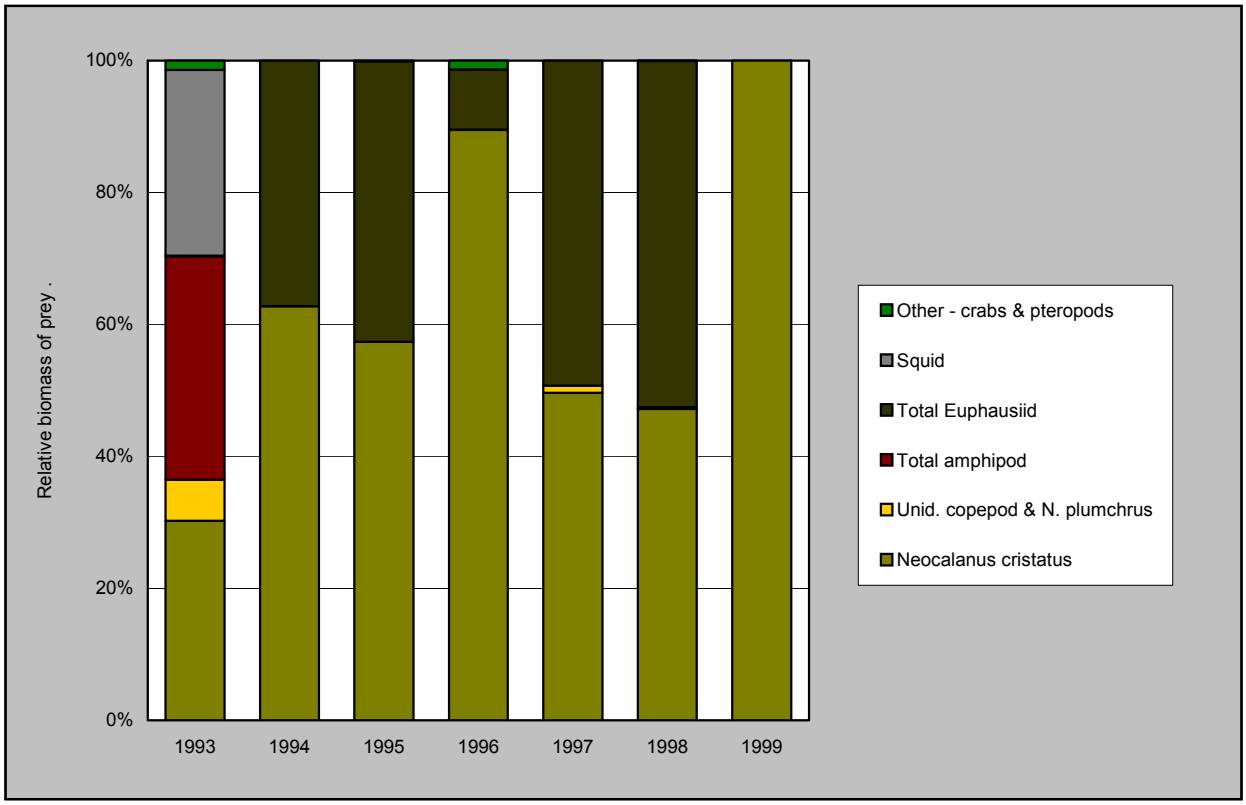

Figure 36. Relative biomass of prey in diets of parakeet auklets at Buldir Island, Alaska.

Table 66. Relative biomass of prey in diets of parakeet auklets at Buldir Island, Alaska. Numbers represent the percentage of the mass of combined food samples comprised by each species.

	1993	1994	1995	1996	1997	1998	1999
No. samples	6	3	16	5	3	12	1
Total mass (g)	14.2	8.6	174.3	24.6	36.8	91.1	0.7
Pteropoda			<0.1	1.3			
Cephalopoda - squid	28.2						
Copepoda							
Neocalanus plumchrus/flemingeri					1.1	<0.1	
N. cristatus	30.3	62.8	57.4	89.2	49.6	43.0	100.0
Unid. Copepoda	6.2						
Amphipoda							
Hyperiidea							
Parathemisto pacifica	32.8			<0.1			
Primno macropa	1.1						
Hyperoche medusarum						0.1	
Gamaridea							
Lysianassidae						0.1	
Euphausiacea							
Thysanoessa spp.	0.1	37.2	42.5	9.5	49.2		
Unid. Euphausiid						47.8	
Decapoda							
Crab zoea			0.1				
Oregoninae	1.4						
Atelecyclidae megalopa						<0.1	

Table 67. Frequency of occurrence of prey in diets of parakeet auklets at Buldir Island, Alaska. Frequency is expressed as the percentage of food samples in which each species was present.

	1993	1994	1995	1996	1997	1998	1999
No. samples	6	3	16	5	3	12	
Pteropoda			6.3	40.0			
Cephalopoda - squid	16.7						
Copepoda							
Neocalanus plumchrus/flemingeri					33.3	8.3	
N. cristatus	50.0	66.7	81.3	100.0	66.7	75.0	100.0
Unid. Copepoda	16.7						
Amphipoda							
Hyperiidea							
Parathemisto pacifica	50.0			20.0			
Primno macropa	16.7						
Hyperoche medusarum						8.3	
Gamaridea							
Lysianassidae						8.3	
Euphausiacea							
Thysanoessa spp.	16.7	33.3	43.8	40.0	66.7		
Unid. Euphausiid						83.3	
Decapoda							
Crab zoea			6.3				
Oregoninae	16.7						
Atelecyclidae megalopa						8.3	

Table 68. Breeding chronology dates for tufted puffins at Buldir Island, Alaska.

Year	mean hatch	SD	n[a]	median hatch	no. nests monitored[b]	first hatch	last hatch	first fledge
1988	19 Jul	3.9	8	18 Jul	17	14 Jul	24 Jul	30 Aug
1990	11 Jul	9.2	15	11 Jul	29	2 Jul	2 Aug	12 Aug
1991	23 Jul	5.9	26	21 Jul	32	12 Jul	6 Aug	>14 Aug[c]
1992	8 Jul	7.2	35	8 Jul	37	26 Jun	26 Jul	>10 Aug
1993	15 Jul	4.0	33	15 Jul	39	8 Jul	23 Jul	24 Aug
1994	10 Jul	6.3	13	9 Jul	24	2 Jul	25 Jul	18 Aug
1995	19 Jul	5.7	33	15 Jul	42	15 Jul	2 Aug	>18 Aug
1996	7 Jul	5.8	7	5 Jul	40	4 Jul	20 Jul	14 Aug
1997	16 Jul	4.8	27	15 Jul	29	9 Jul	24 Jul	>17 Aug
1998	8 Jul	8.9	21	9 Jul	52	25 Jun	23 Jul	>26 Aug
1999	25 Jul	6.7	10	23 Jul	24	13 Jul	4 Aug	24 Aug
2000	4 Jul	7.9	12	2 Jul	30	26 Jun	27 Jul	19 Aug
2001	20 Jul	0.0	1	20 Jul	30	5 Jul	25 Jul	14 Aug
2002	10 Jul	9.9	12	10 Jul	35	25 Jul	4 Aug	6 Aug
2003	23 Jul	6.9	3	27 Jul	13	10 Jul	27 Jul	18 Aug
2004	8 Jul	6.4	11	11 Jul	30	20 Jun	17 Jul	10 Aug

[a] Sample size for calculation of mean and median hatch date estimates only.
[b] The total used for estimating the remaining parameters.
[c] No chicks had fledged (disappeared after reaching min. fledge age) by the time of the last visit in years with a ">" symbol.

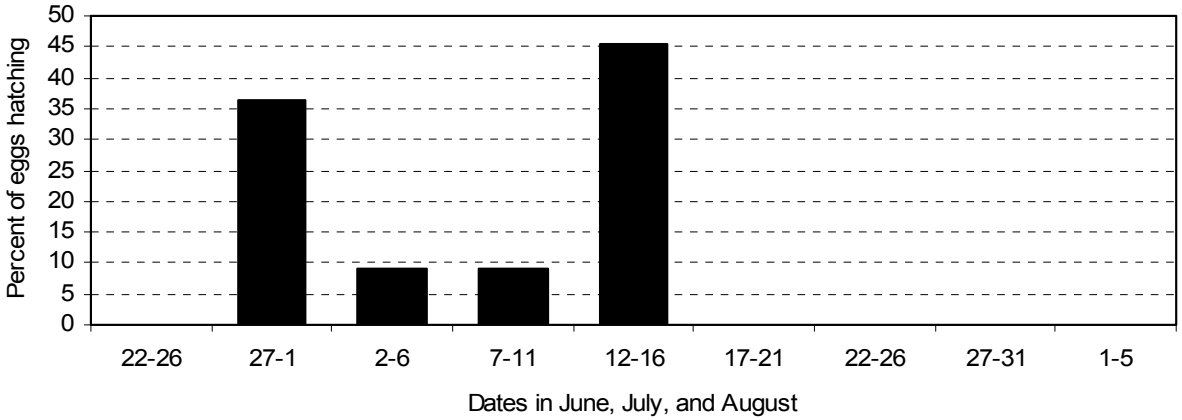

Figure 37. Hatching chronology of tufted puffins at Buldir Island, Alaska in 2004.

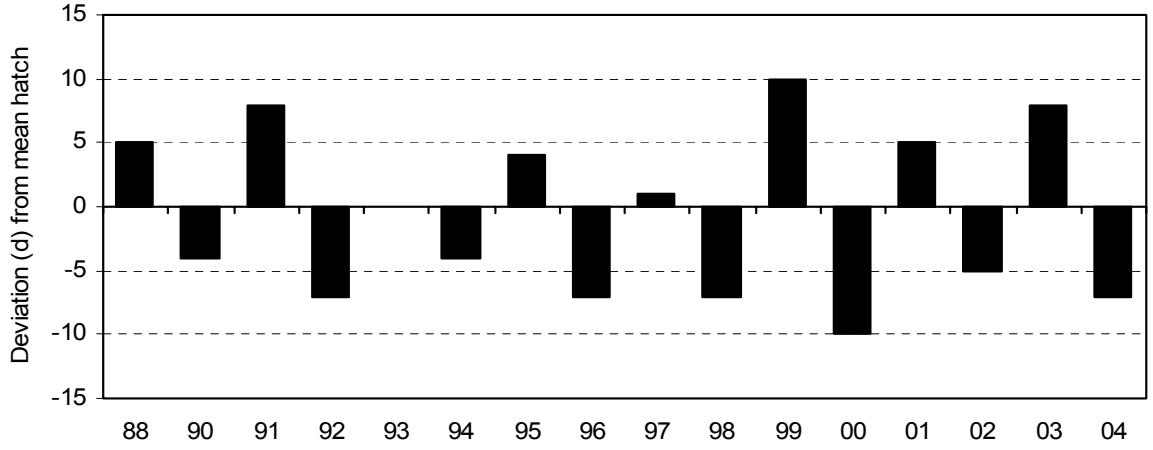

Figure 38. Yearly hatch date deviation (from the 1988-2004 average of 17 July) of tufted puffins at Buldir Island, Alaska. Numbers below the mean indicate hatch dates earlier; positive numbers indicate hatch dates later.

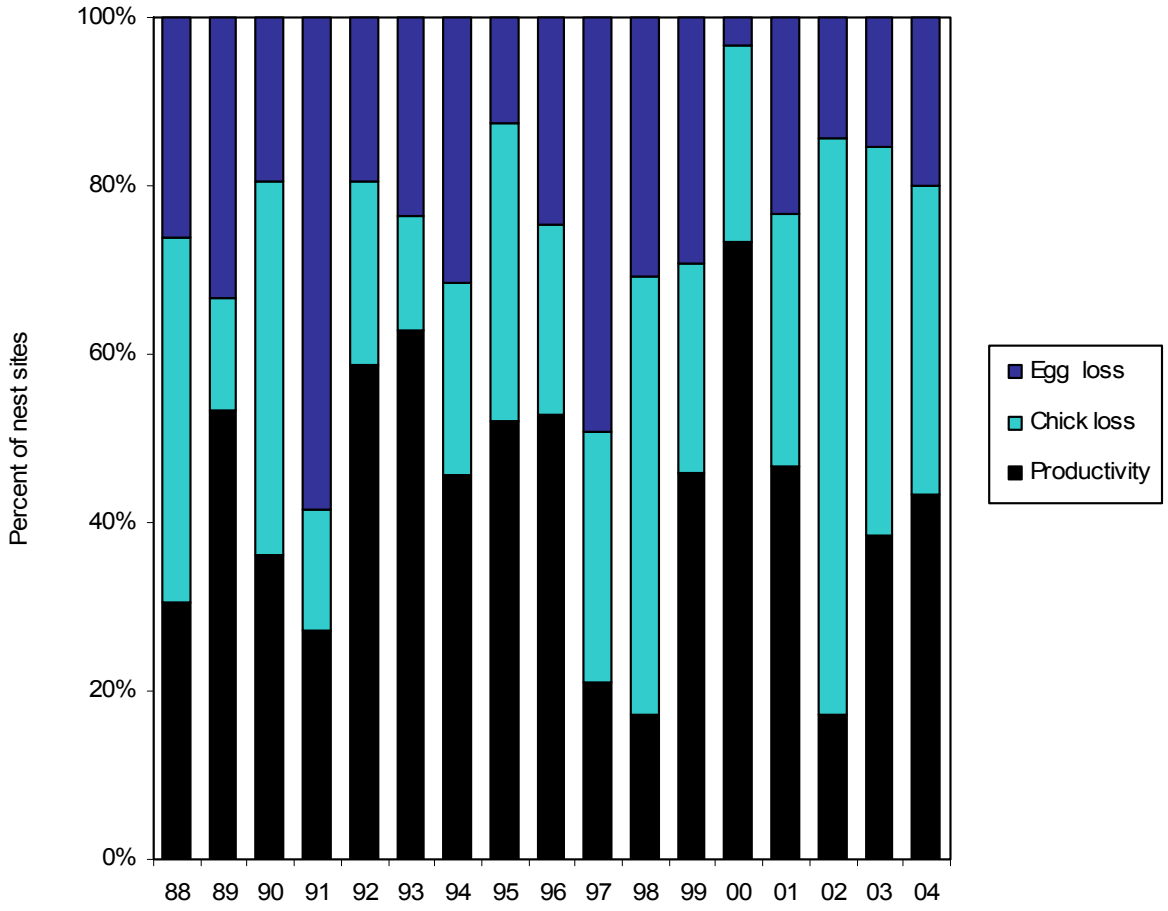

Figure 39. Reproductive performance of tufted puffins at Buldir Island, Alaska. Egg Loss=(A-B)/A; Chick Loss=(B-C)/A; Productivity=C/A, where A=number nest sites, B=number of nest sites with a chick; C=number of nests sites with fledged chick.

Table 69. Reproductive performance of tufted puffins at Buldir Island, Alaska.

Parameter[a]	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
No. eggs found[b] (A)	23	30	36	77	46	51	35	48	53	57	52	24	30	30	35	13	30
No. eggs lost to:																	
disappearance	2	5	5	23	4	11	7	2	6	18	10	2	0	3	4	2	5
abandonment	3	4	2	18	5	1	3	0	1	2	6	5	1	4	0	0	1
breakage	1	1	0	4	0	0	1	4	6	8	0	0	0	0	1	0	0
No. eggs hatched (B)	17	20	29	32	37	39	24	42	40	29	36	17	29	23	30	11	24
No. chicks lost to:																	
disappearance	2	0	14	9	7	6	6	13	6	11	15	6	7	6	14	4	6
death	8	4	2	2	3	1	2	4	6	6	12	2	0	3	10	2	5
No. "successful" chicks (C_{1+2})	7	16	13	21	27	32	16	25	28	12	9	11	22	14	6	5	13
fledged[c] (C_1)	6	6	7	2	9	30	15	8	25	8	0	1	2	2	2	3	2
still present (C_2)	1	10	6	19	18	2	1	17	3	4	9	10	20	12	4	2	11
Hatching success (B/A)	0.74	0.67	0.81	0.42	0.80	0.76	0.69	0.88	0.75	0.51	0.69	0.71	0.97	0.77	0.86	0.85	0.80
Fledging success (C_{1+2}/B)	0.41	0.80	0.45	0.66	0.73	0.82	0.67	0.60	0.70	0.41	0.25	0.65	0.76	0.61	0.20	0.46	0.55
Reproductive success (C_{1+2}/A)	0.30	0.53	0.36	0.27	0.59	0.63	0.46	0.52	0.53	0.21	0.17	0.45	0.73	0.47	0.17	0.38	0.43
Productivity (hs x fs)	0.30	0.54	0.36	0.28	0.58	0.62	0.46	0.53	0.53	0.21	0.17	0.46	0.74	0.47	0.17	0.39	0.44

[a] Nest sites included in productivity estimates were visited at intervals of < 10 days at hatch and fledge/disappearance, but sites with larger intervals were included when the fate was known (dead chick observed, chick still alive at last visit, chick disappeared so early or so late that its fate would be the same even at ±half the visit interval).

[a] Sites at which an apparently incubating bird was observed on 2 consecutive visits were assumed to have an egg, regardless of whether or not a chick was later observed at that site.

[b] For chicks to be considered fledged, they had to be at least 38 days old before disappearing or 33 days old at the time of the last visit, if still present.

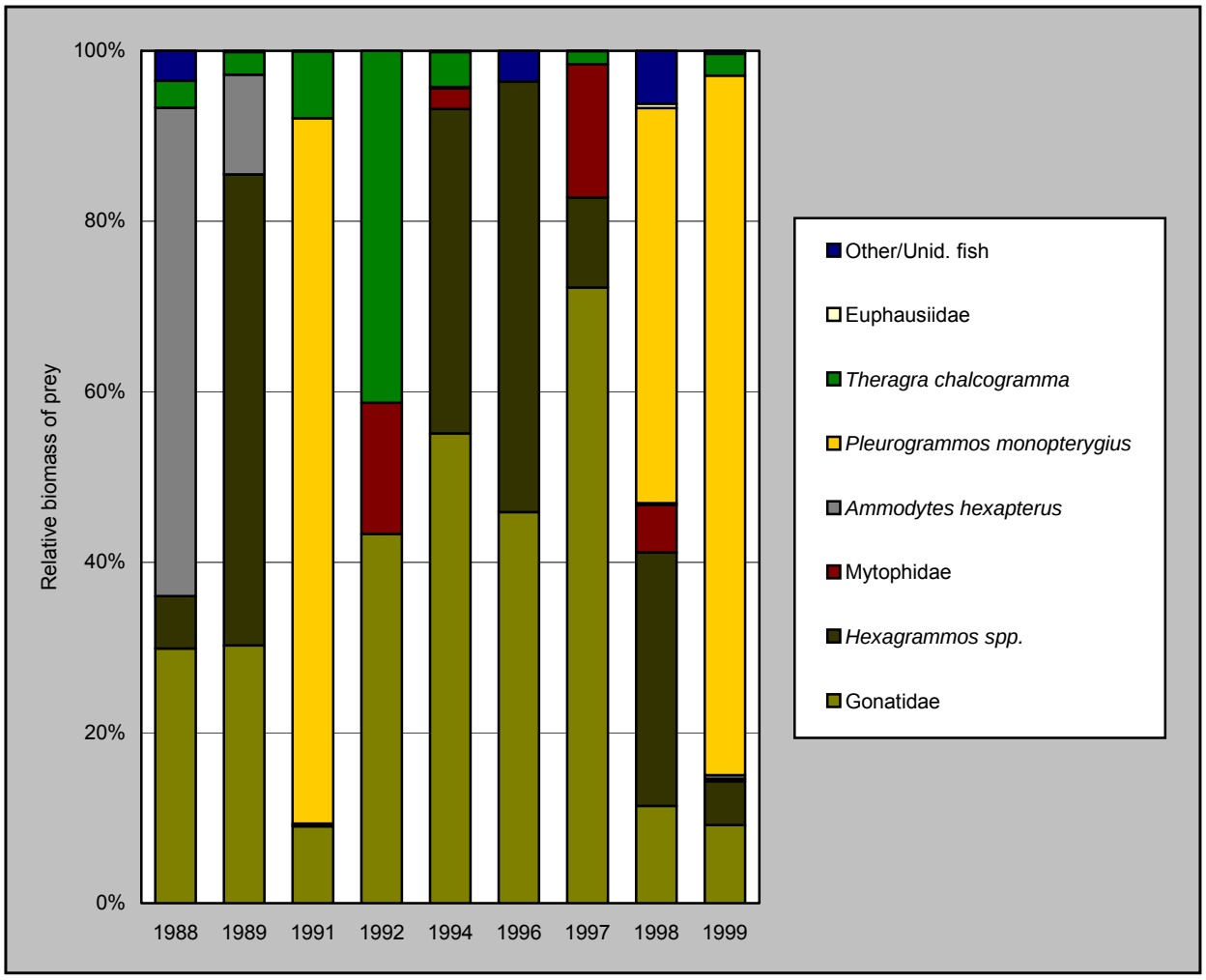

Figure 40. Relative biomass of prey in diets of tufted puffins at Buldir Island, Alaska.

Table 70. Relative biomass of prey in diets of tufted puffins at Buldir Island, Alaska. Numbers represent the percentage of the mass of combined food samples comprised by each species.

	1988	1989	1991	1992	1994	1996	1997	1998	1999
Date: begin	12 Aug	25 Jul	9 Aug	11 Aug	6 Aug	31 Jul	12 Aug	9 Aug	10 Aug
end	5 Sep	15 Aug	12 Aug	11 Aug	18 Aug	17 Aug	17 Aug	15 Aug	21 Aug
No. samples	39	26	36	4	39	17	13	29	31
Total mass (g)	279.2	376.5	608.2	48.7	649.7	196.2	227.1	371.0	464.2
Gonatidae (squid)									
Gonatus middendorffi						32.5	71.8		
Berryteuthis magister						6.7			
Gonatopsis makko							0.4		
Unid. squid	29.9	30.2	9.0	43.3	55.1	6.6		11.4	9.2
Euphausiidae									
Thysanoessa longipes								0.4	
Thysanoessa spp.								0.2	
Fish									
Myctophidae									
Stenobrachius leucopsarus							15.6	1.8	
Unid. Myctophidae				15.4	2.4			3.8	0.3
Gadidae									
Theragra chalcogramma	3.2	2.7	7.8	41.3	4.1		1.5		
Ptilichthyidae									
Ptilichthys goodei		0.1						0.1	
Zaproridae									
Zaprora silenus									0.1
Ammodytidae									
Ammodytes hexapterus	57.3	11.7	0.1		0.2			0.2	0.5
Scorpaenidae						1.4		0.1	
Anoplopomatidae									
Anoplopoma fimbria						0.4			
Hexagrammidae									
Hexagrammos decagrammus					38.1	49.8	10.6	29.7	23.8
Hexagrammos spp.	6.2	55.3	0.2			0.8			
Pleurogrammos monopterygius			82.8					46.4	82.1
Cottidae									
Hemilepidotus spp.						0.6			
Blepsias bilobus								0.4	1.3
Pleuronectidae					0.1	0.4		0.2	
Unid. fish	3.5		0.1			0.8		5.5	

Table 71. Frequency of occurrence of prey in diets of tufted puffins at Buldir Island, Alaska. Frequency is expressed as the percentage of food samples in which each species was present.

	1988	1989	1990	1991	1992	1994	1996	1997	1998	1999
Date: begin	12 Aug	25 Jul	25 Jul	11 Jul	11 Aug	6 Aug	31 Jul	12 Aug	9 Aug	10 Aug
end	5 Sep	15 Aug	10 Aug	12 Aug	11 Aug	18 Aug	17 Aug	17 Aug	15 Aug	21 Aug
No. samples	39	26	23	42	4	39	17	13	29	31
Gonatidae (squid)										
Gonatus middendorffi							29.4	84.6		
Berryteuthis magister							5.9			
Gonatopsis makko								7.7		
Unid. squid	38.5	50.0	69.6	33.3	50.0	75.0	5.9		31.0	12.9
Euphausiidae										
Thysanoessa longipes									3.4	
Thysanoessa spp.									6.9	
Decapoda - shrimp	2.6									
Fish										
Myctophidae										
Stenobrachius leucopsarus								7.7	3.4	
Unid. Myctophidae					25.0	7.5			6.9	3.2
Gadidae										
Theragra chalcogramma	10.3	11.5	8.7	28.6	75.0	22.5		23.1		19.4
Ptilichthyidae										
Ptilichthys goodei		3.8							3.4	
Zaproridae										
Zaprora silenus										3.2
Ammodytidae										
Ammodytes hexapterus	79.5	26.9	4.3	4.8		2.5			3.4	9.7
Scorpaenidae							17.6		3.4	
Anoplopomatidae										
Anoplopoma fimbria							5.9			
Hexagrammidae										
Hexagrammos decagrammus						30.0	47.1	15.4	51.7	25.8
Hexagrammos spp.	12.8	61.5		4.8			11.8			
Pleurogrammos monopterygius			26.1	59.5					27.6	61.3
Cottidae										
Hemilepidotus spp.							11.8			
Blepsias bilobus									3.4	3.2
Pleuronectidae						7.5	5.9		3.4	
Unid. fish	17.9		4.3	4.8			23.5	7.7	17.2	

Table 72. Species composition of prey in diets of tufted puffins at Buldir Island, Alaska. Values are expressed as the percentage of total number of individual prey items comprised by each species for each year.

	1988	1989	1990	1991	1992	1994	1996	1997	1998	1999
Date: begin	12 Aug	25 Jul	25 Jul	11 Jul	11 Aug	6 Aug	31 Jul	12 Aug	9 Aug	10 Aug
end	5 Sep	15 Aug	10 Aug	12 Aug	11 Aug	18 Aug	17 Aug	17 Aug	15 Aug	21 Aug
No. samples	39	26	23	42	4	39	17	13	29	31
No. individual prey items	258	163	117	166	22	129	66	45	88	87
Gonatidae (squid)										
Gonatus middendorffi							22.7	75.6		
Berryteuthis magister							1.5			
Gonatopsis makko								2.2		
Unid. squid	10.5	23.3	82.9	31.9	27.3	58.1	3.0		23.9	19.5
Euphausiidae										
Thysanoessa longipes									13.6	
Thysanoessa spp.									10.2	
Decapoda - shrimp	0.4									
Fish										
Myctophidae										
Stenobrachius leucopsarus								6.7	1.1	
Unid. Myctophidae					4.5	2.3			2.3	1.1
Gadidae										
Theragra chalcogramma	3.9	6.7	7.7	39.8	68.2	20.2		8.9		25.3
Ptilichthyidae										
Ptilichthys goodei		0.6							1.1	
Zaproridae										
Zaprora silenus										1.1
Ammodytidae										
Ammodytes hexapterus	76.0	42.3	2.6	1.2		1.6			1.1	3.4
Scorpaenidae							18.2		1.1	
Anoplopomatidae										
Anoplopoma fimbria							1.5			
Hexagrammidae										
Hexagrammos decagrammus						15.5	27.3	4.4	22.7	10.3
Hexagrammos spp.	4.3	27.0		1.2			4.5			
Pleurogrammos monopterygius			6.0	22.3					12.5	37.9
Cottidae										
Hemilepidotus spp.							6.1			
Blepsias bilobus									1.1	1.1
Pleuronectidae						2.3	4.5		2.3	
Unid. fish	5.0		0.9	3.6			10.6	2.2	6.8	

Table 73. Breeding chronology dates for horned puffins at Buldir Island, Alaska.

Year	mean hatch	SD	n[a]	median hatch	no. nests monitored[b]	first hatch	last hatch	first fledge
1988	22 Jul	6.8	18	23 Jul	38	30 Jun	14 Aug	3 Sep
1989	25 Jul	6.1	7	23 Jul	39	9 Jul	8 Aug	>22 Aug[c]
1990	24 Jul	7.9	19	19 Jul	52	9 Jul	10 Aug	12 Aug
1991	26 Jul	4.7	15	27 Jul	71	15 Jul	6 Aug	>14 Aug
1992	21 Jul	4.8	8	20 Jul	27	11 Jul	5 Aug	>12 Aug
1993	23 Jul	4.5	12	25 Jul	19	15 Jul	3 Aug	28 Aug
1994	22 Jul	3.6	15	23 Jul	36	9 Jul	1 Aug	28 Aug
1995	25 Jul	6.0	10	24 Jul	38	15 Jul	4 Aug	>18 Aug
1996	20 Jul	2.7	13	20 Jul	51	10 Jul	7 Aug	>18 Aug
1997	25 Jul	4.7	21	24 Jul	52	15 Jul	6 Aug	>19 Aug
1998	20 Jul	7.4	16	23 Jul	39	5 Jul	2 Aug	>27 Aug
1999	28 Jul	5.9	13	25 Jul	25	22 Jul	8 Aug	>26 Aug
2000	19 Jul	8.3	21	18 Jul	62	2 Jul	2 Aug	>28 Aug
2001	27 Jul	8.0	13	25 Jul	60	16 Jul	12 Aug	25 Aug
2002	20 Jul	5.1	42	19 Jul	91	21 Jun	7 Aug	>4 Sep
2003	23 Jul	8.4	10	19 Jul	26	9 Jul	12 Aug	24 Aug
2004	24 Jul	5.5	15	23 Jul	53	29 Jun	2 Aug	>24 Aug

[a] Sample size is for calculation of mean and median hatch date estimates only. Nest sites used to determine hatch dates had observations < 8 days apart from egg to chick except in 1989: ≤ 8 days; 1990: ≤10 days; 1993: ≤ 9 days.
[b] The total used for estimating the remaining parameters.
[c] No chicks had fledged (disappeared after reaching min fledging age) by the time of the last visit in years with a ">".

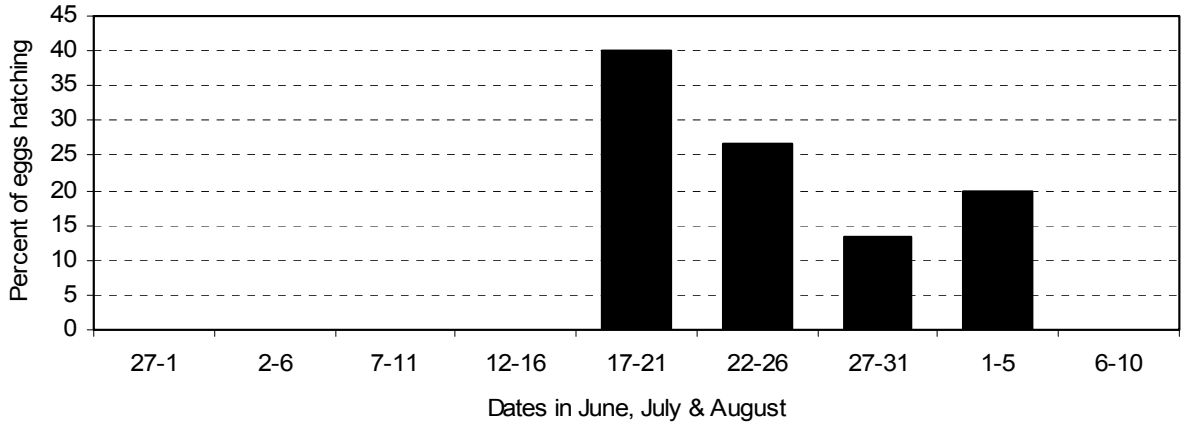

Figure 41. Hatching chronology of horned puffins at Buldir Island, Alaska in 2004.

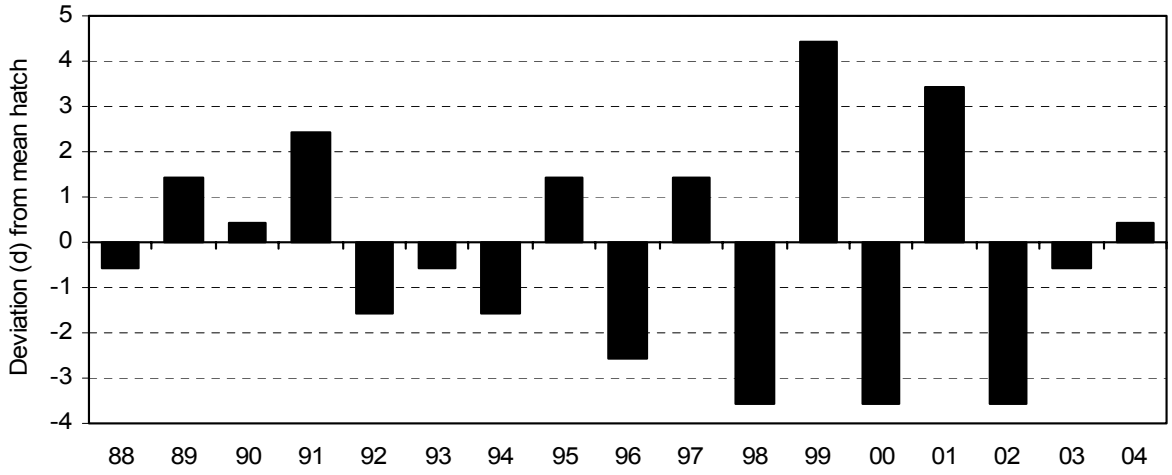

Figure 42. Yearly hatch date deviation (from the 1988-2004 average of 17 July) of horned puffins at Buldir Island, Alaska. Numbers below the mean indicate hatch dates earlier; positive numbers indicate hatch dates later.

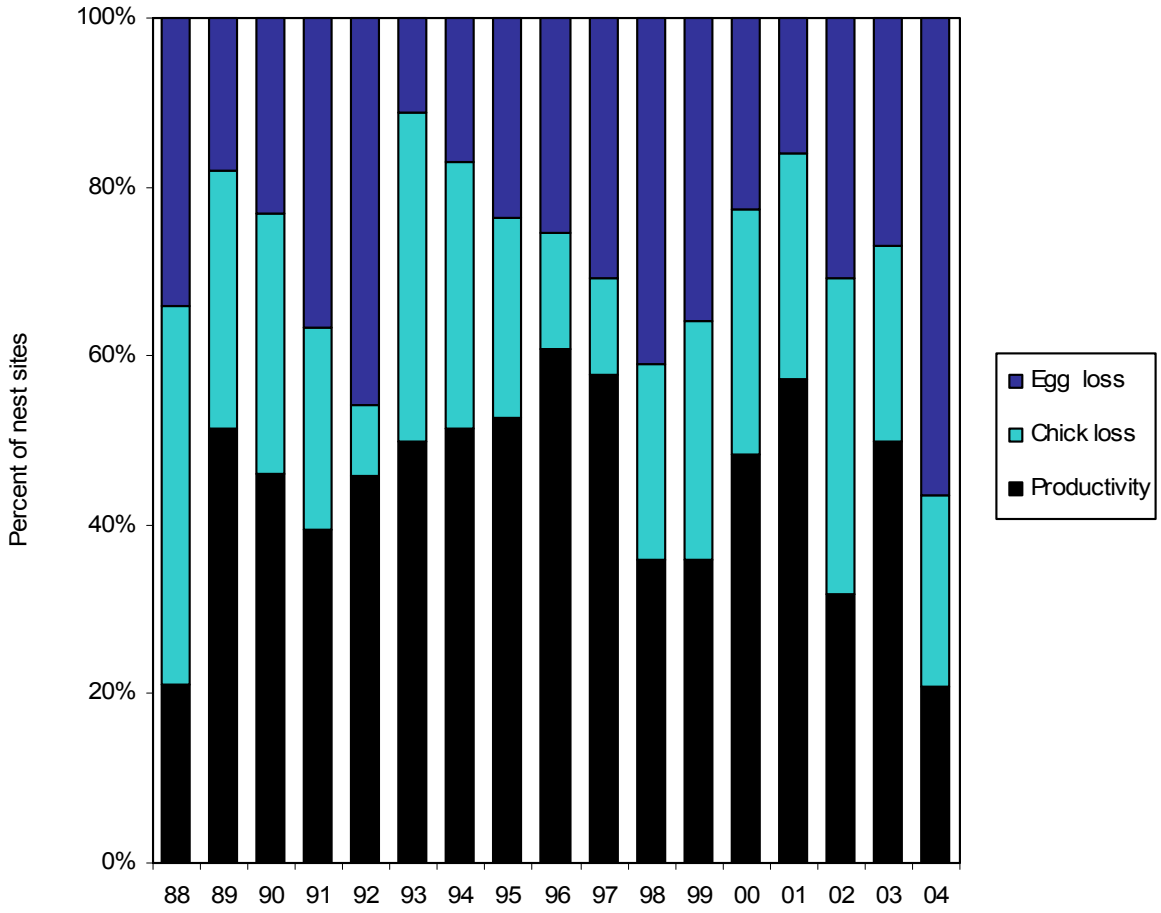

Figure 43. Reproductive performance of horned puffins at Buldir Island, Alaska. Egg Loss=(A-B)/A; Chick Loss=(B-C)/A; Productivity=C/A, where A=number nest sites, B=number of nest sites with a chick; C=number of nests sites with fledged chick.

Table 74. Reproductive performance of horned puffins at Buldir Island, Alaska.

Parameter[a]	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
No. eggs found (A)	38	39	52	71	24	18	35	38	51	52	39	25	62	56	91	26	53
No. eggs lost to:																	
disappearance	11	4	12	11	9	2	5	6	8	11	8	7	14	5	14	5	14
abandonment	2	2	0	11	1	0	0	1	1	2	7	0	0	4	3	1	12
breakage (%)	0	1	0	4	1	0	1	2	4	3	1	2	0	0	11	1	3
No. eggs hatched (B)	25	32	40	45	13	16	29	29	38	36	23	16	48	47	63	19	23
No. chicks lost to:																	
disappearance	12	9	13	9	0	5	7	5	3	5	5	6	16	4	21	3	8
death	5	3	3	8	2	2	4	4	4	1	4	1	2	11	13	3	4
No. "successful" chicks (C_{1+2})	8	20	24	28	11	9	18	20	31	30	14	9	30	32	29	13	11
fledged[b] (C_1)	8	2	1	0	0	9	18	0	9	2	0	0	2	9	0	2	0
still present (C_2)	0	18	23	28	11	0	0	20	22	28	14	9	28	23	29	11	11
Hatching success (B/A)	0.66	0.82	0.77	0.63	0.54	0.89	0.83	0.76	0.75	0.69	0.59	0.64	0.77	0.84	0.69	0.73	0.43
Fledging success (C_{1+2}/B)	0.32	0.63	0.60	0.62	0.85	0.56	0.62	0.69	0.82	0.83	0.61	0.56	0.63	0.68	0.46	0.68	0.48
Reproductive success (C_{1+2}/A)	0.21	0.51	0.46	0.39	0.46	0.50	0.51	0.53	0.61	0.58	0.36	0.36	0.48	0.57	0.32	0.50	0.21
Productivity (hs x fs)	0.21	0.51	0.46	0.39	0.46	0.50	0.52	0.53	0.61	0.58	0.36	0.36	0.49	0.57	0.32	0.50	0.21

[a] Data are from nest sites for which visit intervals at hatching and fledging were $\leq$ 12 days.
[b] For chicks to be considered fledged, they had to be 34 days old before disappearing or 30 days old at the time of the last.

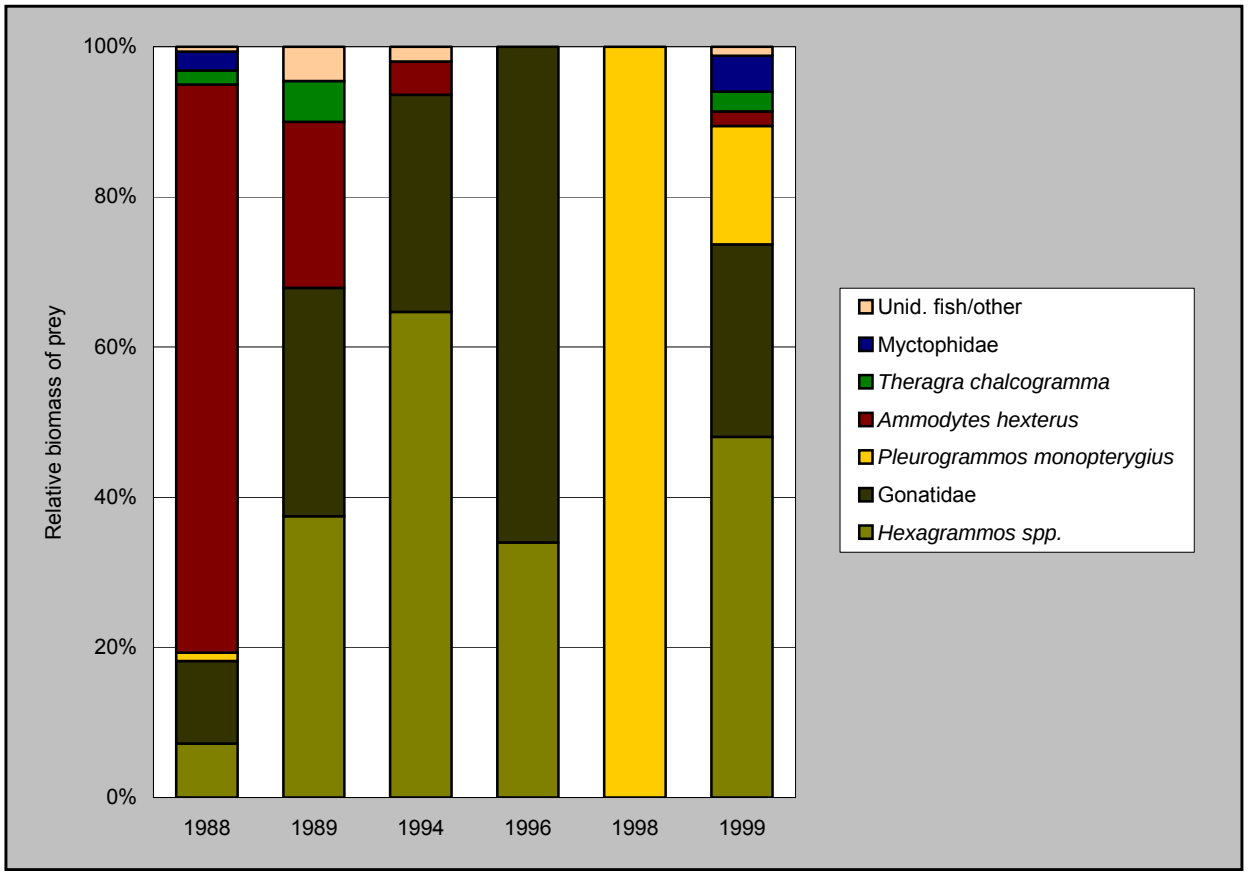

Figure 44. Relative biomass of prey in diets of horned puffins at Buldir Island, Alaska.

Table 75. Relative biomass of prey in diets of horned puffins at Buldir Island, Alaska. Numbers represent the percentage of the mass of combined food samples comprised by each species.

	1988	1989	1994	1996	1998	1999
Date begin	16 Aug	2 Aug	7 Aug	3 Aug	13 Aug	22 Jul
end	5 Sep	15 Aug	14 Aug	17 Aug	13 Aug	21 Aug
No. samples	33	16	3	3	1	28
Total mass (g)	399.2	92.1	20.4	36.5	5.8	348.9
Gonatidae (squid)						
Gonatus middendorffi				66.0		
Unid. squid	11.0	30.4	28.9			25.7
Fish						
Myctophidae						
Stenobrachius leucopsarus	2.5					4.8
Gadidae						
Theragra chalcogramma	1.9	5.4				2.6
Ammodytidae						
Ammodytes hexapterus	75.7	22.1	4.4			1.9
Hexagrammidae						
Hexagrammos decagrammus			64.7	34.0		42.8
Hexagrammos spp.	7.2	37.5				5.2
Pleurogrammos monopterygius	1.1				100.0	15.8
Agonidae	0.1					
Pleuronectidae			2.0			
Unid. fish	0.5	4.6				1.2

Table 76. Frequency of occurrence of prey in diets of horned puffins at Buldir Island, Alaska. Frequency is expressed as the percentage of food samples in which each species was present.

	1988	1989	1990	1991	1994	1996	1998	1999
Date begin	16 Aug	2 Aug	27 Jul	22 Jul	7 Aug	3 Aug	13 Aug	22 Jul
end	5 Sep	15 Aug	10 Aug	11 Aug	14 Aug	17 Aug	13 Aug	21 Aug
No. samples	33	16	45	42	3	3	1	28
Gonatidae (squid)								
Gonatus middendorffi						33.3		
Unid. squid	18.2	31.3	20.0	7.1	33.3			31.6
Fish								
Myctophidae								
Stenobrachius leucopsarus	3.0							2.6
Gadidae								
Gadus macrocephalus			2.2					
Theragra chalcogramma	3.0	12.5	17.8	9.5				5.3
Ammodytidae								
Ammodytes hexapterus	93.9	68.8	57.8	45.2	33.3			18.4
Hexagrammidae								
Hexagrammos decagrammus					100.0	66.7		52.6
Hexagrammos spp.	12.1	31.3	4.4	4.8				23.7
Pleurogrammos monopterygius	3.0		66.7	64.3			100.0	7.9
Agonidae	3.0							
Pleuronectidae			2.2	2.4	33.3			
Unid. fish	9.1	6.3	2.2	2.4				13.2

Table 77. Species composition of prey in diets of horned puffins at Buldir Island, Alaska. Values are expressed as the percentage of total individual prey items comprised by each species.

	1988	1989	1990	1991	1994	1996	1998	1999
Date begin	16 Aug	2 Aug	27 Jul	22 Jul	7 Aug	3 Aug	13 Aug	22 Jul
end	5 Sep	15 Aug	10 Aug	11 Aug	14 Aug	17 Aug	13 Aug	21 Aug
No. samples	33	16	45	42	3	3	1	28
No. individual prey items	273	70	261	196	14	7	1	189
Gonatidae (squid)								
Gonatus middendorffi						57.1		
Unid. squid	4.0	32.9	7.7	6.6	28.6			20.1
Fish								
Myctophidae								
Stenobrachius leucopsarus	0.4							2.6
Gadidae								
Gadus macrocephalus			0.4					
Theragra chalcogramma	4.0	5.7	11.1	2.6				3.2
Ammodytidae								
Ammodytes hexapterus	85.3	50.0	61.3	60.2	35.7			8.5
Hexagrammidae								
Hexagrammos decagrammus					21.4	42.9		24.9
Hexagrammos spp.	1.8	8.6	1.1	7.1				31.2
Pleurogrammos monopterygius	0.4		17.6	21.9			100.0	4.2
Agonidae	0.7							
Pleuronectidae			0.4	0.5	14.3			
Unid. fish	3.3	2.9	0.4	1.0				5.3

Table 78. Numbers of birds detected on off-road point count route number 315, Buldir Island, Alaska. Surveys were conducted on 8 June 1995, 9 June 1996, and 12 June 1997, 18 June 1998, 12 June 2001, 17 June 2002, and 14 June 2003. No point count was conducted in 2004. For those species marked with an asterisk, we observed pairs, nests, and/or territorial males.

Species	1995[a]	1996	1997	1998	2000	2001	2002	2003	Mean
Fork-tailed storm-petrel*	6	0	1	1	-	0	0	0	1.1
Leach's storm-petrel	0	1	0	0	-	0	0	0	0.1
Aleutian Canada goose*	133	112	85	22	-	70	2	76	71.4
Parasitic jaeger	2	2	8	5	-	1	2	1	3.0
Glaucous-winged gull*	60	142	161	66	-	18	20	34	71.6
Parakeet auklet	1	3	12	0	-	1	0	0	2.4
Tufted puffin	0	0	0	1	-	0	0	0	0.1
Bald eagle	1	0	0	0	-	0	0	0	0.1
Winter wren*	1	6	9	1	-	5	4	7	4.7
Song sparrow*	10	10	8	3	-	2	1	2	5.1
Lapland longspur* - total	30	26	22	14	-	18	31	18	22.7
male	24	22	17	11	-	--	--	13	12.4
female	5	3	3	0	-	--	--	0	1.6
unknown	1	1	2	3	-	18	31	5	8.7
Snow bunting*	9	6	14	1	-	2	8	0	5.7
Rosy finch*	2	4	1	9	-	1	5	0	3.1
Common rosefinch	0	0	1	0	-	0	0	0	0.1

[a] Total number of individuals detected on survey

Table 79. Counts of sea otters at Buldir Island, Alaska.

Year	Date	A-B	B-C	C-D	D-E	E-F	F-A	Total	Survey type	Source
1959[a]	19 May	0	0	0	0	0	0	0	aerial	
1962[b]	25-28 June	--	--	--	--	--	--	7	boat	Jones 1963
1963[c]	7-19 July	14		--	--	--	--	14	boat	Kenyon 1969
1965	2 May	--	--	--	--	--	--	15	aerial	Kenyon 1969
1972[d]	7 July	--	--	--	--	--	--	>27	boat	Byrd 1972
1974[e]	18 July	--	--	--	--	--	20	>20	boat	G. Vernon Byrd, unpubl. Data
1979	23-24 June	4	2	0	4	11	15	36	boat	Day et al. 1979
1988[f]	26 June	--	--	--	--	--	--	95	boat	
1989[g]	13 June	11	14	3	13	14	3	58	boat	U.S. Fish and Wildl. Serv. Unpubl. data
1992	April	--	--	--	--	--	--	11	aerial	Evans et al. 1997
1995	28 June	0	0	2	0	0	0	2	boat	U.S. Fish and Wildl. Serv. Unpubl. data
1997	3 June	--	--	--	--	--	--	4	boat	U.S. Fish and Wildl. Serv. Unpubl. data
1998	13 June	0	1	5	3	1	0	10	boat	U.S. Fish and Wildl. Serv. Unpubl. data
1999	1 July	0	0	0	0	2	2	4	boat	U.S. Fish and Wildl. Serv. Unpubl. data
2000	20 June	0	0	0	0	5	0	5	boat	U.S. Fish and Wildl. Serv. Unpubl. data
2001	5 June	0	0	0	0	0	0	0	boat	U.S. Fish and Wildl. Serv. Unpubl. data
2002	2 July	0	0	0	6	0	1	7	boat	U.S. Fish and Wildl. Serv. Unpubl. data

[a] Aerial count was conducted in less than ideal conditions.
[b] Includes 1 male and 3 females with pups.
[c] Includes 5 females with young and 4 lone adults along the north coast of the island (A-B and B-C).
[d] Partial boat survey around Northwest Point.
[e] Partial boat count.
[f] Partial boat counts, East Cape - Peregrine Point, approximately C-D and D-E (75 adults, 20 pups).
[g] Includes 2 pups.

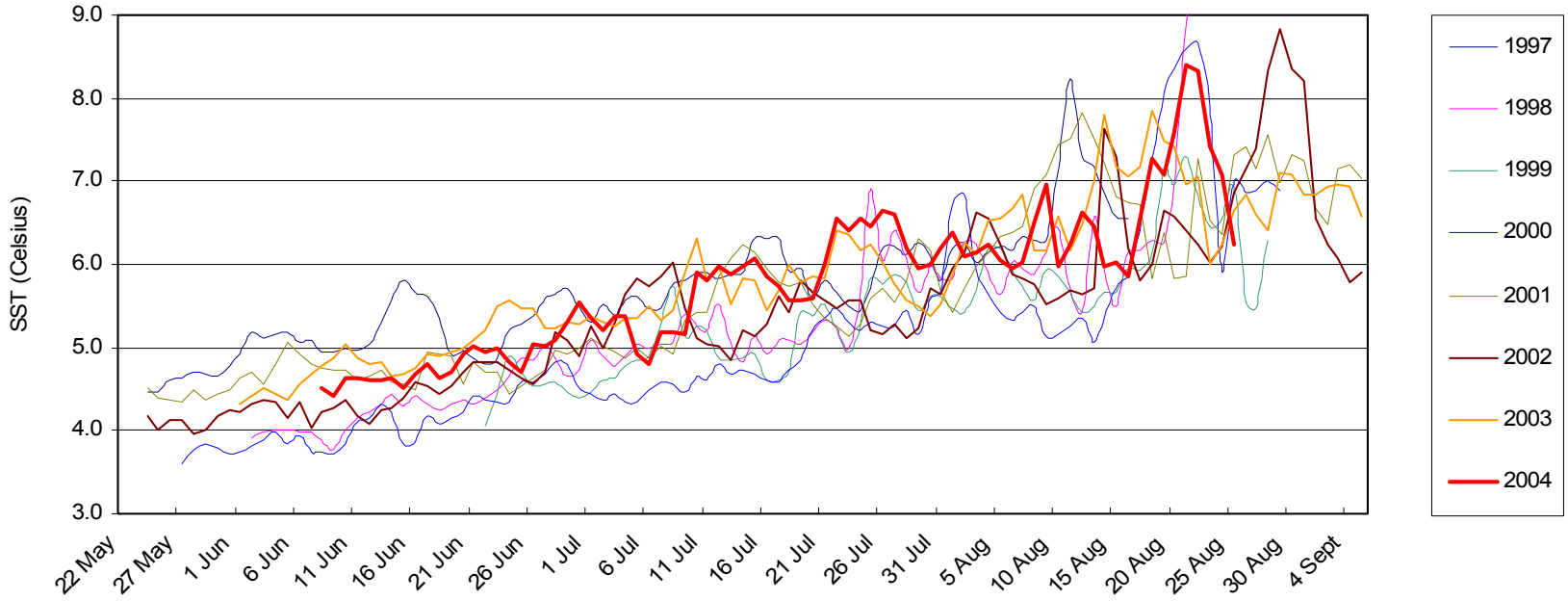

Figure 45. Sea surface temperature (ºC)at Buldir Island, Alaska. Values are the daily mean temperature.

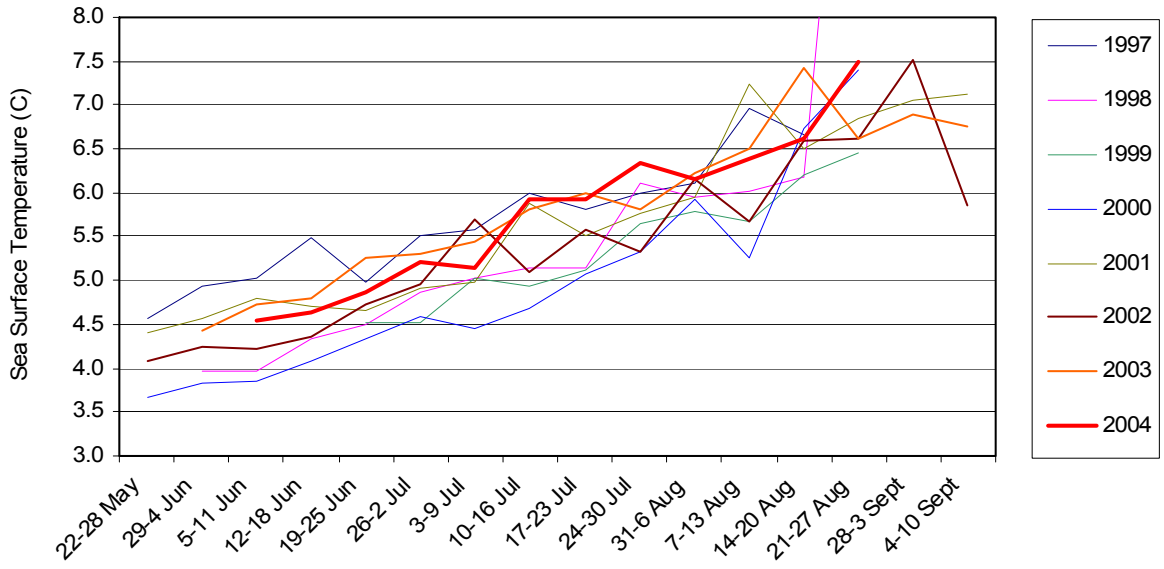

Figure 46. Weekly Sea Surface Temperature (ºC) at Buldir Island, Alaska in various years.

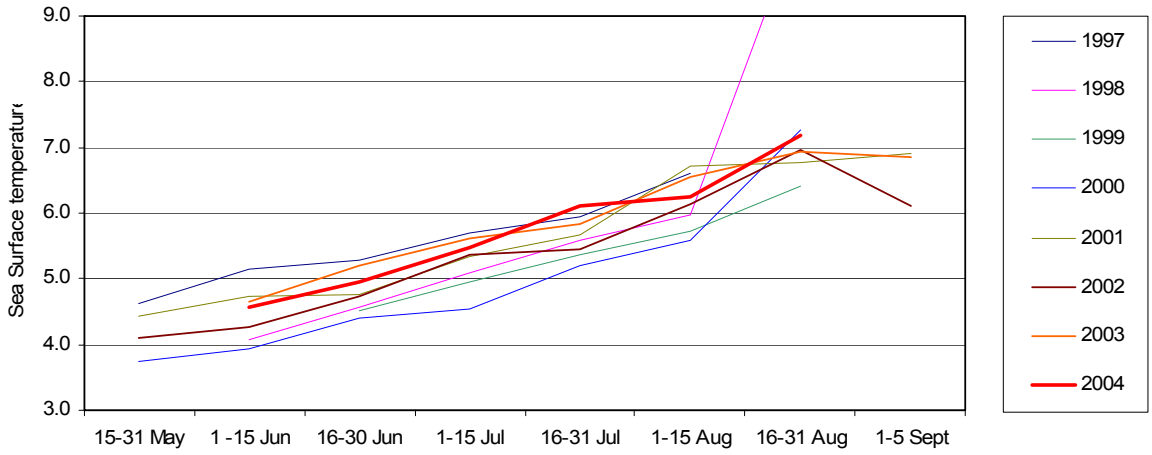

Figure 47. Biweekly Sea Surface Temperature (ºC) at Buldir Island, Alaska in various years.

Table 80. Biweekly mean SST (ºC) at Buldir Island, Alaska. Composite of mean daily temperatures.

Date	1997	1998	1999	2000	2001	2002	2003	2004
15-31 May	4.6	--	--	3.7	4.4	4.1	--	--
1-5 Jun	5.2	4.1	--	3.9	4.7	4.3	4.7	4.6
16-30 Jun	5.3	4.6	4.5	4.4	4.7	4.7	5.2	4.9
1-15 Jul	5.7	5.1	5.0	4.5	5.3	5.4	5.6	5.5
16-31 Jul	5.9	5.6	5.4	5.2	5.7	5.5	5.8	6.1
1-15 Aug	6.6	6.0	5.7	5.6	6.7	6.1	6.6	6.2
16-31 Aug	--	10.5	6.4	7.3	6.8	7.0	6.9	7.2
1-5 Sept	--	--	--	--	6.9	6.1	6.8	--

Table 81. Weekly mean SST (ºC) at Buldir Island, Alaska. Composite of mean daily temperatures.

Date	1997	1998	1999	2000	2001	2002	2003	2004
22-28 May	4.6	--	--	3.7	4.4	4.1	--	--
29-4 Jun	4.9	4.0	--	3.8	4.6	4.2	4.4	--
5-11 Jun	5.0	4.0	--	3.8	4.8	4.2	4.7	4.5
12-18 Jun	5.5	4.3	--	4.1	4.7	4.4	4.8	4.6
19-25 Jun	5.0	4.5	4.5	4.3	4.7	4.7	5.3	4.9
26-2 Jul	5.5	4.9	4.5	4.6	4.9	5.0	5.3	5.2
3-9 Jul	5.6	5.0	5.0	4.5	5.0	5.7	5.4	5.1
10-16 Jul	6.0	5.1	4.9	4.7	5.9	5.1	5.8	5.9
17-23 Jul	5.8	5.1	5.1	5.1	5.5	5.6	6.0	5.9
24-30 Jul	6.0	6.1	5.7	5.3	5.8	5.3	5.8	6.3
31-6 Aug	6.1	6.0	5.8	5.9	6.0	6.2	6.2	6.2
7-13 Aug	7.0	6.0	5.7	5.3	7.2	5.7	6.5	6.4
14-20 Aug	6.7	6.2	6.2	6.7	6.5	6.6	7.4	6.6
21-27 Aug	--	12.7	6.4	7.4	6.8	6.6	6.6	7.5
28-3 Sep	--	--	--	--	7.1	7.5	6.9	--
4-10 Sep	--	--	--	--	7.1	5.9	6.8	--

Annotated list of species observed at Buldir Island, Alaska, 26 May — 23 August 2004.

Abundance categories were defined as follows:
Abundant: >50 individuals per day or 6 per hour
Common: 10-49 individuals per day or 2-5 per hour
Fairly Common: 5-9 individuals per day or 1 per hour
Uncommon: 2-4 individuals per day or <1 per hour
Rare: 1 individual per day
Very Rare: <1 individual per day; sightings throughout summer
Casual: Irregular numbers of birds outside their expected range. Usually 1-5 sightings total.

Birds

Laysan Albatross (*Phoebastria immutabilis*) – Very rare. Birds were irregularly seen throughout the summer from Northwest Ridge and when on the M/V Tiglax just offshore from the island.

Northern Fulmar (*Fulmarus glacialis*) – Common. Confirmed Breeder. Nests in small colonies at East Cape, Kittiwake Lane, and Spike Camp—density appeared high at East Cape colony on. Most birds are dark morphs.

Fork-tailed Storm-Petrel (*Oceanodroma furcata*) – Abundant. Confirmed breeder. Nests in burrows and crevices over most of the island. Productivity and density was monitored at 6 plots near camp and South Marsh.

Leach's Storm-Petrel (*Oceanodroma leucorhoa*) – Abundant. Confirmed breeder. Nests sympatrically with Fork-tailed Storm-Petrel.

Pelagic Cormorant (*Phalacrocorax pelagicus*) – Common. Confirmed breeder. Nests on sea-facing cliffs around the island.

Red-faced Cormorant (*Phalacrocorax urile*) – Fairly common. Confirmed breeder. Nests along northeast and southern coastline cliffs. One nest was monitored at base of Slide Mountain where highest density of PECO's were observed nesting. Most nests observed and monitored (10 monitored) were above the steep cliff face that we call East Cape. Birds here were seen nesting and roosting above 30 meters and up to 70 meters (more or less; the nests are difficult to see here and best observed from just offshore in skiff. Known to nest on sea-facing cliffs elsewhere on island.

Bewick's Swan *(Cygnus cygnus)* — Rare. One individual was present throughout most of the summer, making South Marsh its transient home. First sighted on 28 May in South Marsh, it was noted to look very weak and did not take flight. It was observed in South Marsh up through June and on 13 July was sighted in Camp Valley—it was first observed wandering from South Marsh. Later towards the end of July, it was observed to fly a short distance across South Marsh. On 20 August, our swan was found to have met his/her demise in South Marsh—RIP dear friend.

Aleutian Canada Goose (*Branta canadensis leucopareia*) - Abundant. Confirmed breeder. Present in all vegetated areas except for highest alpine. Seen just above low plant community line in alpine areas in small groups, especially later in the season—early August. Appeared to be feeding on Angelica leaves here. First nest observed on 30 May near mouth of Glissade Valley—incubating adult flushed off nest with six eggs, one appeared very recently laid. Also on 30 May, another nest midway up Glissade Valley contained three eggs. On 1 June several pairs were observed nesting on the Main Talus and one nest contained two eggs. 7 June, a pair of adults with four goslings was observed on NWR along NW cliff-side where vegetation is less dense and more diverse. Also on 7 June, many nests were observed on NWR, the majority observed containing

five eggs. 19 June, goslings were becoming a common sight. On 21 June, observed a Glaucous-wing Gull consuming a gosling near Gentle Valley—goslings abundant across island. 12 July, many adults were observed molting and flightless in the Bunting Creek watershed—the highest density of occurrence here was between 120 meters and 300 meters in elevation and on the NW side of the watershed near Bull Ridge. Also on 12 July, many goslings observed with pin feathers. 3 August, first groups seen flying about since molting began. 5 August, geese flying in groups again a common sight around the island.

Green-winged Teal (*Anas crecca*) – Very rare. Pairs or individuals of both sexes were observed at Bean Goose Pond, in the small pond at South Marsh, Dip Pond, and in the small ponds at Spike. Pairs or individuals observed on 7, 10, 14, 15, 21 and 29 June; and then on 23 August.

Eurasian Wigeon (*Anas penelope*) – Very rare. One individual seen in stream near cabin on 26 May carrying vegetation in mouth. On 27 May, 20 were observed in Bean Goose Pond and again on 28 May, 12 were observed in said pond.

Northern Pintail (*Anas acuta*) – Very rare. Three were observed at Bean Goose Pond on 28 May and then later on 28 June, a single bird was sighted.

Garganey *(Anas querquedula)* — Very Rare. Two sightings of a single female, both in North Marsh, on 2 and 6 June.

Common Pochard *(Aythya ferina)* — Very Rare. A single male observed in Bean Goose Pond on 27 and 28 May, and on 7 June.

Tufted Duck *(Aythya fuligula)* — Very Rare. Observed several times in the early part of the summer. On 27 May, eight individuals were sighted at Bean Goose Pond and on 28 May, two individuals were observed—one in Bean Goose Pond, and the other near camp in North Marsh. A single male was observed in Bean Goose Pond again on 12 June. A possible sighting of a pair on 26 June at Kittiwake Lake.

Greater Scaup *(Aythya marila)* — Casual. Two individuals were observed on 30 May.

Common Eider (*Somateria mollissima*) – Common. Confirmed breeder. Groups of birds were seen regularly throughout the season in nearshore waters. Female flushed and appeared to be nesting near Petrel Valley Creek, although nest could not be located. Many pairs and individuals were observed around Middle Rock on 13 July. Also on 13 July, adult male was observed beginning to molt.

Harlequin Duck (*Histrionicus histrionicus*) – Common. Small groups (<10 birds) were seen consistently along coast near NWR and then all along coast from Crested Point to Kittiwake Lane throughout the summer.

Bald Eagle (*Haliaeetus leucocephalus*) – Rare. Confirmed breeder. Pair of adults observed often around South Marsh and in Bunting Creek area. A nest was located far up Bunting Creek with two eggs and then was not observed again. A pair of roosts that appeared to be in frequent use were located midway up Bunting Creek on the NW side of the stream, about 40 feet upslope on a rocky projection—loads of pellets here. Juveniles were seen sporadically over North Marsh and in Glissade Valley, and in June could be noticed by the raucous they cause amongst the geese.

Peregrine Falcon (*Falco peregrinus*) – Fairly common. Confirmed breeder. Nesting birds were observed above the Main Talus, somewhere above North Rocks, another nester in the high cliffs between North Rocks and Petrel Valley Creek, and then at Peregrine Point. Adult observed roosting on the Main Talus throughout summer—did not seem to cause as much of a stir amongst the local auklets as the Glaucous-wing Gulls did over the rocks. Only observed hunting auklets over water and not over rocks on Talus. Observed a Glaucous-wing Gull pirating a Crested Auklet from an

adult Peregrine over the water near North Rocks. Also, observed an adult attempting to snatch a Song Sparrow very near main camp.

Gyrfalcon (*Falco rusticolus*) – Casual. A single individual was observed on 7 June near main camp at dusk at over 100 yards away, flying into the glare of twilight and then rapidly disappearing.

Mongolian Plover (*Charadrius mongolus stegmanni*) – Casual. One individual was seen on North bight Beach on 31 May.

Wandering Tattler (*Heteroscelus incanus*) – Casual. Two individuals were seen on 6 June.

Gray Tailed Tattler (*Heteroscelus brevipes*) – Casual. Four individuals seen over the summer. The first was heard only near camp on 27 May and later sighted on 31 May. Another was seen about halfway up Glissade Valley along the stream bank on 9 August. One was seen again near camp on 23 August as well.

Wood Sandpiper (*Tringa glareola*) – Very Rare. Several individuals and small groups were observed in the early part of the season in the Camp Valley. A single bird was sighted on 26 May, two birds on 27 May, seven plus birds on 28 May, four birds on 30 May and again on 2 June, and 3 birds on 6 June.

Common Sandpiper (*Actitis hypoleucos*) – Casual. An individual bird was observed in South Marsh on 27, 29, and 31 May.

Terek Sandpiper (*Xenus cinereus*) – Casual. An individual bird was observed at the mouth of Tattler Creek hanging-out in the large pool just above the foot bridge on 11 August, and again later on 16 August on beach kelp at the mouth of Tattler Creek.

Bar-tailed Godwit (*Limosa lapponica*) – Casual. A single individual was observed on 29 May.

Ruddy Turnstone (*Arenaria interpres*) – Uncommon. Seen frequently in August when walking to Kittiwake Lane and observed on North bight Beach, near Gull Slide, and several times at Kittiwake Lane. First one seen on 28 May and then none sighted again until August, where four were seen on 6 August and three were seen on 23 August.

Long-toed Stint (*Calidris subminuta*) – Very Rare. All observations of this species were in the North Marsh area. Solitary birds were sighted on 29 and 30 May, two individuals were sighted on 31 May, three individuals on 2 and 3 June, and two on 6 June.

Red-necked Stint (*Calidris ruficollis*) – Casual. A single bird was observed on 30 May.

Pectoral Sandpiper (*Calidris melanotos*) – Casual. A single bird was observed on 29 May.

Common Snipe (*Gallinoga gallinoga*) – Casual. A single bird was observed on 27 May.

Parasitic Jaeger (*Stercorarius parasiticus*) – Common. Confirmed breeder. Dark phase birds were seen and heard throughout the summer most often on the walk over the pass to Spike Camp. A pair of birds was seen commonly over camp valley and numerous times roosting on high mossy-mounds in the center of the valley in early June. Also in early June, this same pair, presumably, was observed bathing in North Marsh amidst all the geese. Many (over 30 birds) were seen in the area of Jaeger Plateau on 12 July and many others were seen in the area between upper Glissade Valley and Buldir Eccentric on 26 June (over 20 birds), 4 August (over 10 birds), and again on 13 August (over 10 birds). Others were sighted and heard over South Marsh on several occasions throughout the summer.

Common Black-headed Gull (*Larus ridibundus*) – Casual. A single individual was observed on North bight Beach on 29 May.

Slaty-backed Gull (*Larus schistisagus*) – Two recorded sightings, both of single individuals, one on 29 May and another on 9 June. These birds were both observed mixed in with a large group of Glaucous-wing Gulls that crowd around the mouth of Tattler Creek on North bight Beach.

Glaucous-winged Gull (*Larus glaucenscens*) – Abundant. Confirmed breeder. Birds nested all along coast line with highest densities between North Rocks and Petrel Valley Creek, West Gull Slide to East Gull Slide, a few from Crested Point to Main Talus, and around the backside of Northwest Ridge. Other nesting areas were located inland near a steady source of water: South Marsh, Bean Goose Pond, Extra Plateau, midway up Glissade Valley, lower Bunting Creek before it enters South Marsh, Dip Valley, and Tip Valley. GWG would congregate in large numbers (100 to 200 plus birds) near mouth of Tattler Creek on North bight Beach daily throughout summer and seemingly do nothing but stand around. First hatch was observed on 9 June in the Main Talus area—birds here fairly aggressive, as I was struck in the face by individual "protecting" a fledgling.

Black-legged Kittiwake (*Rissa tridactyla*) – Abundant. Confirmed breeder. Nests in large colonies at East Cape, Kittiwake Lane, Spike Camp, Peregrine Point, and Middle and Outer Rocks. Birds were observed incubating at Kittiwake Lane on 5 June, and two chicks were observed in separate nests on 20 June at Spike.

Red-legged Kittiwake (*Rissa brevirostris*) – Abundant. Confirmed breeder. Nests in large colonies at East Cape, Kittiwake Lane, Spike Camp, Peregrine Point, and Middle and Outer Rocks.

Common Murre (*Uria aalge*) – Abundant. Confirmed breeder. Nests sympatrically with Thick-billed Murre at East Cape, Kittiwake Lane, Spike Camp, and Middle and Outer Rocks. The highest density observed was at Middle Rock on 13 July, where a mean of 94 birds were counted in Plot 7 during a population count.

Thick-billed Murre (*Uria lomvia*) – Abundant. Confirmed breeder. Nests at East Cape, Kittiwake Lane, Spike Camp and on Middle and Outer Rocks. On 7 June, birds were seen attending colonies at Spike and none were observed to be on eggs. On 10 June, several birds were observed on eggs at Spike. During the 13 July population count of Middle Rock, many birds (over 2000) were in attendance and on eggs.

Pigeon Guillemot (*Cepphus columba*) – Common. Confirmed breeder. Birds were regularly seen just offshore all along the north and east coasts. Up to 10 birds were observed in a single day between Main Talus and Kittiwake Lane on 7 August. The highest observed occurrence of birds was noted on many occasions to be just offshore between West Gull Slide and East Gull Slide. Molting birds were observed after mid to late July in this area several times. Nesting pairs with bill loads were observed in the Main Talus area and around North Rocks.

Ancient Murrelet (*Synthliboramphus antiquus*) – Abundant. Confirmed breeder. A major fledging exodus seemed to be taking place on 8 July around 0100 hrs, when over 100 fledglings were seen and/or heard between Crested Point and camp heading out to sea. Ian Jones' weather-pot was invaded throughout the night by fledglings on the go and many were seen around cabin. A single chick was observed on 22 July, just behind the main cabin in a burrow—it appeared strong and to possess "a real go-getter" attitude.

Cassin's Auklet (*Ptychoramphus aleuticus*) – Abundant. Confirmed breeder. Birds were heard and seen entering burrows while over-nighting at Spike Camp. On 8 July five adult birds were caught in mist nets when "whiskering" at Crested Point—all had food and gurged for/all over us.

Parakeet Auklet (*Cyclorrhynchus psittacula*) – Abundant. Confirmed breeder. Nests in talus areas at Northwest Ridge, Spike Camp Valley, and in smaller numbers at Main Talus (Super Upper), Crested Point, and at Spike along the coast southwest of where trail drops down to beach. This later area mentioned was found to be the best for collecting food samples via mist-net. Fledglings were frequently found wandering aimlessly about the camp area at Spike in August and responded well to a good toss over the cliffs—flying energetically out to sea.

Least Auklet (*Aethia pusilla*) – Abundant. Confirmed breeder. Primary nesting colonies are found at Main Talus, Spike Camp Valley, Middle and Outer Rocks.

Whiskered Auklet (*Aethia pygmaea*) – Abundant. Confirmed breeder. Nests primarily at Northwest Ridge, Main Talus, Crested Point, Spike Camp valley, and Middle and Outer Rocks.

Crested Auklet (*Aethia cristatella*) – Abundant. Confirmed breeder. Found in large numbers on talus slopes around the island. Primary nesting sites include Main Talus, Spike Camp Valley, and Middle and Outer Rocks.

Tufted Puffin (*Fratercula cirrhata*) – Abundant. Confirmed breeder. Abundant on steep, grassy slopes and talus slopes around the island. On 25 June, chicks were observed outside of productivity plots in burrows in Spike Valley.

Horned Puffin (*Fratercula corniculata*) – Abundant. Confirmed breeder. Abundant in talus slopes around island. Productivity was monitored at Main Talus and most successfully at Spike Camp.

Common Cuckoo (*Cuculus canorus*) – Casual. Several birds were observed in June. A single individual was seen at South Marsh on 1 June and on 2 June, four individuals were seen at South Marsh in one sitting (much to Ian Jones' joy). A single bird was seen perched in a nook on a cliff-face above the ocean at North Rocks on 5 June, and another individual was sighted in Spike Valley "flitting about" on 10 June.

Gray-spotted Flycatcher (*Muscicapa griseisticta*) – Casual. An individual was sighted near the main cabin on 31 May and another individual on 1 June. On 2 June, four individuals were seen around main camp; 3 June, a single bird sighted; and on 7 June, two birds were also sighted.

Common Raven (*Corvus corax*) – Uncommon. A single, very raggedy-looking bird was observed between North Rocks and Petrel Valley Creek on 31 May being mobbed and attacked by a pair of Peregrine Falcons. On 18 July, a pair of birds was first observed in the North Rocks area, both appearing very healthy. This pair remained on the island throughout the rest of the summer—frequenting Camp Valley, Spike Valley, and Glissade Valley. Would often escort us, physically and vocally, for a distance going to and from Spike.

Tree Swallow (*Tachycineta bicolor*) – Casual. A single bird was observed by several of us over North Marsh on 28 May.

Barn Swallow (*Hirundo rustica*) – Very Rare. A solitary bird appeared on the island the evening after a storm passed on 18 June and spent the following week around main camp, roosting on the eave above the door and on the clothesline behind the main cabin.

Winter Wren (*Troglodytes troglodytes*) – Abundant. Confirmed breeder. Commonly seen along the coast and amidst lowland vegetation.

Red-breasted Flycatcher *(Ficedula parva)* — Casual. A single male was observed on 6 June near Main Talus.

Siberian Rubythroat (*Luscinia calliope*) – Casual. Four individuals were seen on 31 May, one near main camp and three in South Marsh. Four were again seen on 2 June and on 3 June. On 6 June, a male and female were sighted and then on 7 June, a pair of males was observed.

Red-flanked Bluetail *(Tarsiger cyanurus)* — Very Rare. A solitary female was observed 28, 30, and 31 May, and on 7 June in the Cuckoo Creek drainage area.

Eyebrowed Thrush (*Turdus obscurus*) – Casual. On 26 May, a single male was observed near the main cabin and on 30 May, a male was seen near the mouth of Glissade Creek. The last one seen of the summer was a male observed on 7 June in Cuckoo Creek.

Yellow Wagtail (*Motacilla flava*) – Casual. Individuals were observed in the North Marsh area on 28, 30, and 31 May, and on 1 and 3 June. Five individuals were sighted on 2 June and two on 2 June.

Gray Wagtail (*Motacilla cinerea*) – Casual. Individual males were observed on 26 May at the mouth of Tattler Creek; on 2 June, 3 June, and 4 June near the main cabin; and on 9 June again at the mouth of Tattler Creek.

Song Sparrow(*Melospiza melodia*) – Abundant. Confirmed breeder. Commonly seen at lower elevations, especially near coast. Fledglings were observed on 9 June east of Crested Point and then on 10 June in Spike Valley.

Lapland Longspur (*Calcarius lapponicus*)- Abundant. Confirmed breeder. Commonly seen in all lowland vegetation communities on the island.

Snow Bunting (*Plectrophenax nivalis*) – Common. Confirmed breeder. Commonly seen or heard in the upland areas, especially on the west side of High Pass.

Rustic Bunting *(Emberiza rustica)* — Casual. A solitary male was observed on 26 May near the main cabin, and again on 27 May and on 3 June at South Marsh.

Grey-crowned Rosy Finch (*Leucosticte arctoa*) – Fairly common. Confirmed breeder. Commonly seen in all lowland vegetated communities as well as on cobble beaches and observed on Middle Rock. More numerous around camp than either Song Sparrows, Lapland Longspurs or Winter Wrens.

Brambling (*Fringilla montifringilla*) – Casual. Individuals were observed on 28 May, 4 June, and 6 June in the main camp area.

Common Rosefinch *(Carpodacus erythrinus)* — Casual. A solitary female was observed on 31 May. On 21 June, a solitary male was seen near “hut” at Spike Camp. A solitary male was also sighted in the area of North Marsh sometime in mid to late June.

Hawfinch (*Coccothraustes coccothraustes*) – Casual. One individual seen on 31 May.

Marine Mammals

Sea Otter (*Enhydra lutris*) – Rare. One individual was seen in the Spike area in early June. On 13 July, an adult with a yearling was observed on the seaward side of Outer Rock. On 25 July, a single adult was observed swimming along 50 feet offshore, rolling about in the breakers and headed north along coast near Spike.

Harbor Seal (*Phoca vitulina*) – Fairly common. Individuals and groups of up to 4 animals were seen throughout the season mainly between Crested Point and Kittiwake Lane. Two adults, with a pup each, were observed hauling out on the rocky beach just east of North Rocks in mid to late July.

Northern Fur Seal *(Callorhinus ursinus)*—Casual?. A possible sighting was made on Outer Rock on 13 July. Seen only fleetingly entering water off of haul-out rock. 95% sure of ID—large pectoral flippers and head profile lead us to this conclusion.

Stellar Sea Lion (*Eumetopias jubatus*) – Fairly common. One to three animals were observed regularly in the Main Talus area. Individuals or groups of up to fifteen were seen frequently throughout the summer just offshore from Spike. On one occasion, a large group (15+), with several large males, came very near the beach at Spike and were quite vocal.

Dall's Porpoise *(Phocoenoides dalli)* — Rare. A pod of 8 individuals was observed from the M/V Tiglax on 7 June, and a larger pod of 10+ was encountered while skiffing to Kittiwake Lane on 13 July.

Orca *(Orcinus orca)* — Very Rare. A single adult male was sighted near East Cape on 18 July, and a pair of adults was sighted just offshore from Main Talus on 11 August.

Sperm Whale (*Physeter macrocephalus*) – Very Rare. Seen on two occasions spouting far offshore.