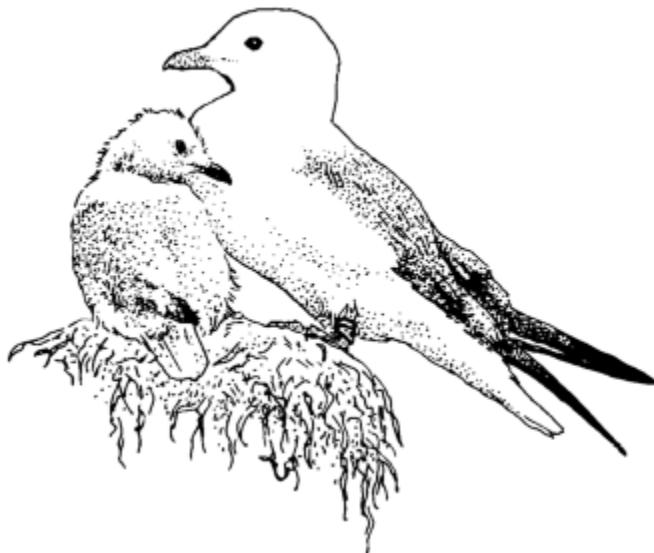


BIOLOGICAL MONITORING AT BULDIR ISLAND, ALASKA IN 2003: SUMMARY APPENDICES



Nathan Jones, Martin Murphy, Jeff Williams, Erik Andersen, and Meredith Barrett

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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" 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*

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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 2003 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) population indices for black-legged and red-legged kittiwakes; and thick-billed murres 4) food habits data for storm-petrels, kittiwakes, auklets, and puffins, and 5) survival data for adult red-legged kittiwakes.

Detailed results of the 2003 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 ($52^{\circ}21' N$, $176^{\circ}56' E$) 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 $7.7^{\circ}C$ in the summer and $3.7^{\circ}C$ 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, a 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° C in late May and rise to 5-6° C in August. Occasionally, anomalous events occur such as in 1998 when sea surface temperature rose to an unusually high 12° 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-- Three observers were present on Buldir in 2003 from 01 June through 05 September. Nathan Jones was the camp leader and was assisted by Martin Murphy and volunteer Naomi Sugimura. Travis Clarke worked on auklet biology and provided help around camp and on other occasions. Hector Douglas and Brie Drummond conducted work on a special project looking at fatty acids and corticosteroid levels in seabirds. Dr. Ian Jones participated in observations and directed auklet resighting efforts during the first week of June.

Data Collection and Analysis.—We followed data collection and analysis methods as outlined in Williams *et al.* (2002). We deleted the following portions of our monitoring program:

- Food habits data for 2000, 2001, 2002, and 2003 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.
- Population counts of Middle Rock were not completed in 2003.

ACKNOWLEDGMENTS

We would like to thank the crew of the M/V *Tiglax* for safe transport to the island and their expert assistance throughout the field season. The monitoring program would not exist without the guiding influence and vision of Vern Byrd who has tirelessly shaped and molded the monitoring program over the years. It would not exist today without his efforts. The hard work and dedication of everyone is greatly appreciated.

LITERATURE CITED AND SELECTED REFERENCES

- Bailey, E.P. 1993. Introduction of foxes to Alaskan islands- history, effects on avifauna, and eradication. U.S. Fish and Wildl. Serv Resource Publ. 193. Washington D.C. 53 pp.
- Byrd, G.V. 1972. Notes of the Buldir Island expedition - 30 June thru 08 July 1972. U.S. Fish and Wildl. Serv. Rep. Adak, Alas. 12 pp.
- Byrd, G.V. 1978. Birds of Buldir Island, Alaska with notes on abundance and nesting chronology. U.S. Fish and Wildl. Serv. Rep. Adak, Alas. 132 pp.
- Byrd, G.V. 1984. Vascular vegetation of Buldir Island, Aleutian Islands, Alaska compared to another Aleutian Island. Arctic 37:37-48.
- Byrd, G.V., and L.A. Climo. 1988. The status of ledgenesting seabirds in the western Aleutian Islands, Alaska in summer1988. U.S. Fish and Wildl. Serv. Rep. Adak, Alas. 63 pp.

- Byrd, G. V., and R.H. Day. 1986. The avifauna of Buldir Island, Aleutian Islands, Alaska. *Arctic* 39:109-118.
- Byrd, G.V., and H.D. Douglas. 1989. The status of ledge-nesting seabirds at monitoring sites in the Aleutian Islands, Alaska in 1989. U.S. Fish and Wildl. Serv. Rep. Adak, Alas. 62 pp.
- Byrd, G.V., and J.C. Williams. 1994. Buldir Island, Alaska: a major monitoring site for seabirds. *Beringian Seabird Bulletin* 2:29
- Coats R.R., 1953. Geology of Buldir Island, Aleutian Islands, Alaska. Geological Survey Bull. 989-A. Washington, D.C.
- Corbett, D.G., C. Lefevre, T. J. Corbett, D. West, and D. Siegel-Causey. 1997. Excavations at KIS-008, Buldir Island: evaluations and potential. *Arctic Anthropology* 34:100-117.
- Cooney, R.T. 1981. Bering sea zooplankton and micronecton communities with emphasis on annual production. In: Hood, D.W., Calder, J.A. (eds) the eastern Bering Sea shelf: oceanography and resources, Vol. 1. Office of Marine Pollution Assessment, NOAA, Juneau, pp 947-974.
- Day, R.H., B.E. Lawhead, T.J. Early, and E.B. Rhode. 1980. Results of bird and mammal surveys of the western Aleutians - Summer 1979. U.S. Fish and Wildl. Serv. Rep. Adak, Alas. 140 pp.
- Dragoo, D.E., and G.V. Byrd. 1999. Seabird, Marine Mammal, and oceanography Coordinated Investigations at Buldir Island, Aleutian Islands, Alaska, July 1988 (SMMOCI-98-3). U.S. Fish and Wildl. Serv. Rep. AMNWR 99/05. Homer Alas. 72 pp.
- Dragoo, D.E., G.V. Byrd, and D.B. Irons. 2000. Breeding success and population trends of selected seabirds in Alaska in 1999. U.S. Fish and Wildl. Serv. Rep. AMNWR 00/02 61 pp.
- Evans, T.J., D.M. Burn, A.R. Degange. 1997. Distribution and relative abundance of sea otters in the Aleutian Archipelago. U.S. Fish and Wildl. Serv. Tech. Rep. MMM 97-5. Anch, Alas.
- Hipfner, J.M., J.C. Williams, and G.V. Byrd. 1991. The status of kittiwakes and murres at Agattu and Buldir Islands 1988-1990. U.S. Fish and Wildl. Serv. Rep. Adak, Alas. 69 pp.
- Jones, R.D. 1963. Buldir Islands, site of a remnant breeding population of Aleutian Canada geese. *Wildfowl Trust 14th Ann. Rep.* 1961-62, pp80-84
- Kenyon, K.W. 1969. The sea otter in the eastern Pacific ocean. No. Am. Fauna, No. 68. U.S. Fish and Wildl. Serv. Washington, D.C. 352 pp.
- Knudtson, E.P., and G.V. Byrd. 1982. Breeding biology of crested, least, and whiskered auklets on Buldir Island, Alaska. *Condor* 84:197-202.
- Lefevre, C., and D. Siegel-Causey. 1993. First report of bird remains from Buldir Island, Aleutian Islands, Alaska. *Archaeofauna* 2:83-96.
- Lefevre, C. D.G. Corbett, D. Siegel-Causey. 1997. A zooarchaeological study at Buldir Island, Western Aleutians, Alaska. *Arctic Anthropology* 34:118-131.
- Moore, H. P. Kappes, and M. Grinnell. Biological monitoring at Buldir Island, Alaska in 2001: Summary appendices. U.S. Fish and Wildl. Serv. Rep. AMNWR 01/11 Adak, Alas. 36 pp.
- Springer, A.M., J.F. Piatt, and G. Van Vliet. 1996. Seabirds as proxies of marine habitats and food webs in the western Aleutian Arc. *Fish. Oceanogr.* 5:45-55.
- Trapp, J.L. 1979. Variation in summer diet of Glaucous-winged gulls in the western Aleutian Islands: an ecological interpretation. *Wilson Bulletin* 91:412-419.
- Williams, J.C., and G.V. Byrd. 1992. The status of kittiwakes and murres at Agattu and Buldir Islands 1988-1991. U.S. Fish and Wildl. Serv. Rep. Adak, Alas. 68 pp.
- Williams, J.C., J.B. Fischer, L.J. Meehan, and M.A. Ortwerth. 1997. The status of kittiwakes and murres at Buldir Island, Alaska in 1995. U.S. Fish and Wildl. Serv. Rep. AMNWR 97/04. Adak, Alas. 55 pp.
- Williams, J.C., L.J. Meehan, J.B. Fischer, and L.M. Scharf. 1997. Seabird monitoring at Buldir Island, Alaska in 1996: Summary appendices. U.S. Fish and Wildl. Serv. Rep. AMNWR 97/08. 73 pp
- Williams, J.C., M. Ortwerth, and N. Rojek. 1998. Biological monitoring at Buldir Island, Alaska in 1997: Summary appendices. U.S. Fish and Wildl. Serv. Rep. AMNWR 98/05 Adak, Alas. 184 pp.
- Williams, J.C., J. Fischer, A. Palmer. 2001. Biological monitoring at Buldir Island, Alaska in 1998: Summary appendices. U.S. Fish and Wildl. Serv. Rep. AMNWR 99/03. Adak, Alas. 132 pp.
- Williams, J.C., and J. Daniels. 2001. Biological monitoring at Buldir Island, Alaska in 1999: Summary appendices. U.S. Fish and Wildl. Serv. Rep. AMNWR 01/15. Adak, Alaska. 103pp.
- Williams, J.C., L. Scharf, and G.V. Byrd. 2002. Ecological monitoring methods of the Aleutian Islands Unit, Alaska Maritime National Wildlife Refuge. U.S. Fish and Wildl. Serv. Rep. AMNWR 00/01v.2. Adak Alas. 351 pp.

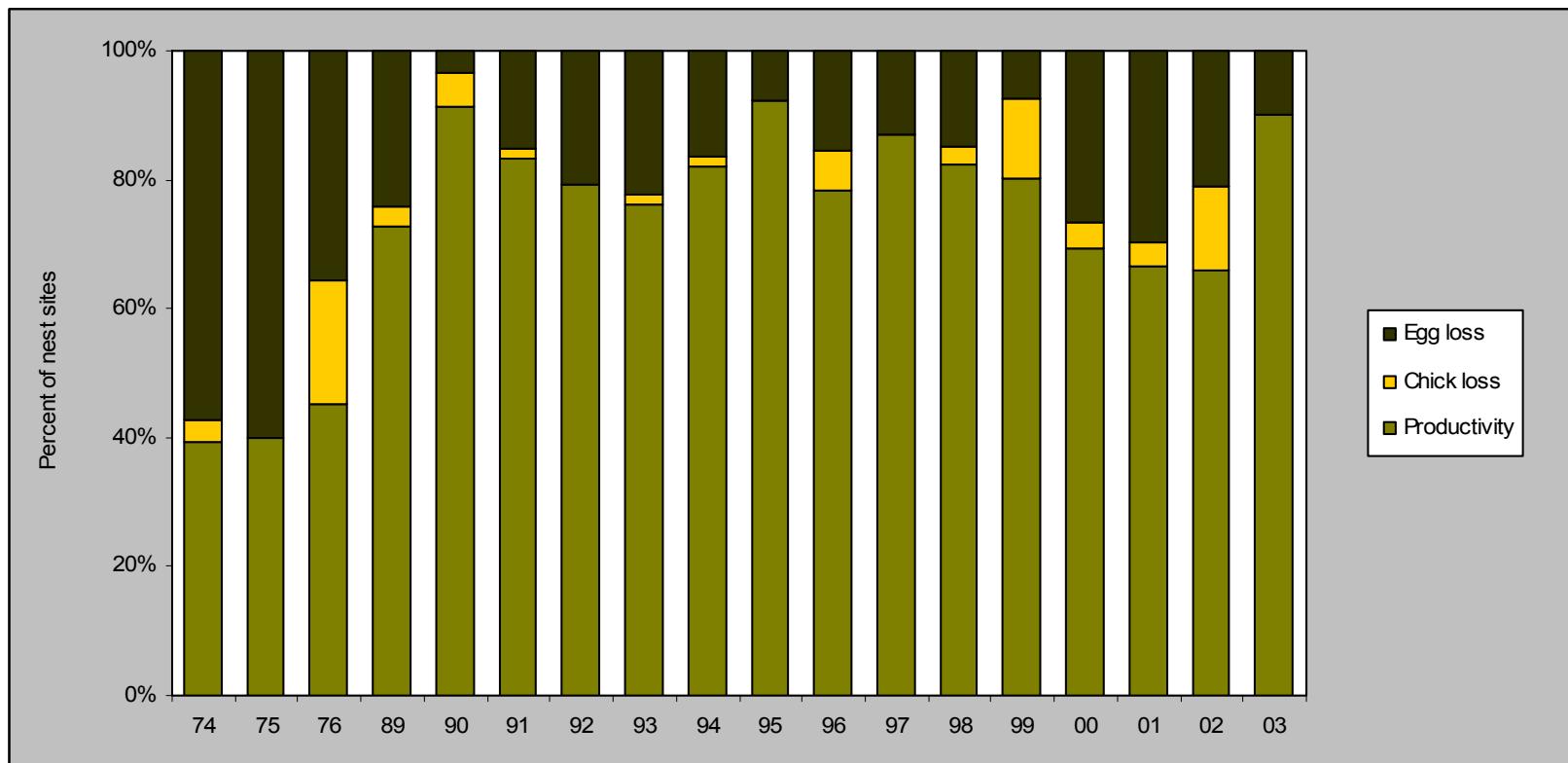


Figure 1. Reproductive performance of Leach's storm-petrels at Buldir Island, Alaska. These values represent the maximal reproductive potential. Actual values were undoubtedly lower. Egg loss=(C-D)/C; Chick loss=(D-E)/C; Productivity=E/C, where C=number of eggs, D=number of eggs hatched, E=number of 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	1996	1997	1998	1999	2000	2001	2002	2003
No. burrows w/ known contents (A)	69	71	113	232	285	287	294	249	297	280	308	277	282	265	304	189	285	116
No. occupied burrows (B)	28	20	31	85	75	82	87	74	72	78	89	90	52	91	75	56	85	45
No. eggs w/ known fate (C)	28	20	31	66	57	66	48	63	61	64	78	77	40	66	75	54	85	40
eggs lost to:				disappearance	--	--	10	1	10	10	14	10	3	12	6	2	1	7
				abandonment	--	--	3	1	0	0	0	0	0	0	2	0	2	0
				breakage	--	--	--	3	0	0	0	0	2	0	2	1	4	0
No. eggs remaining at last visit (unknown fate) ^a	--	--	--	18	18	16	39	11	11	13	10	7	14	17	7	1	2	0
No. chicks (D)	12	8	20	50	55	56	38	49	51	59	66	67	34	61	55	38	67	36
chicks lost to:				disappearance ^b	--	--	0	0	3	0	0	0	4	0	0	2	3	0
				death	--	--	6	2	2	1	0	1	0	1	0	1	6	0
No. chicks potentially successful (E)	11	8	14	48	52	55	38	48	50	59	61	67	33	53	52	36	56	36
chicks disapp. at unk. age or >55d	--	--	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
chicks still present at last visit	11	8	14	48	52	55	38	47	50	59	61	67	30	53	52	36	56	36
Occupancy rate (B/A)	0.41	0.28	0.27	0.37	0.26	0.29	0.30	0.30	0.24	0.28	0.29	0.32	0.18	0.34	0.25	0.30	0.30	0.39
Hatching success (D/C)	0.43	0.40	0.65	0.72	0.96	0.85	0.79	0.78	0.82	0.92	0.85	0.87	0.85	0.92	0.73	0.70	0.79	0.90
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	0.92	1.00	0.97	0.87	0.95	0.95	0.84	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	0.78	0.87	0.83	0.80	0.69	0.67	0.66	0.90

^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, 2003.

Parameter	Plot						All plots	SD
	1	2	3	4	7	8		
No. burrows w/ known contents (A)	9	20	8	18	32	29	116	
No. occupied burrows (B)	4	6	1	4	20	10	45	
No. eggs w/ known fate (C)	4	6	1	4	16	9	40	
eggs lost to:								
disappearance	0	0	0	2	0	0	2	
abandonment	0	1	0	0	0	1	2	
breakage	0	0	0	0	0	0	0	
No. eggs remaining at last visit (unknown fate)	0	0	0	0	0	0	0	
No. chicks (D)	4	5	1	2	16	8	36	
chicks lost to:								
disappearance ^a	0	0	0	0	0	0	0	
death	0	0	0	0	0	0	0	
No. chicks potentially successful (E)	4	5	1	2	16	8	36	
chicks disapp. at unk. age or >55d	0	0	0	0	0	0	0	
chicks still present at last visit	4	5	1	2	16	8	36	
Occupancy rate (B/A)	0.44	0.30	0.13	0.22	0.63	0.35	0.39	0.08
Hatching success (D/C)	1.00	0.83	1.00	0.50	1.00	0.89	0.90	0.06
Fledging success (E/D) ^b	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Reproductive success (E/C) ^b	1.00	0.83	1.00	0.50	1.00	0.89	0.90	0.06

^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.

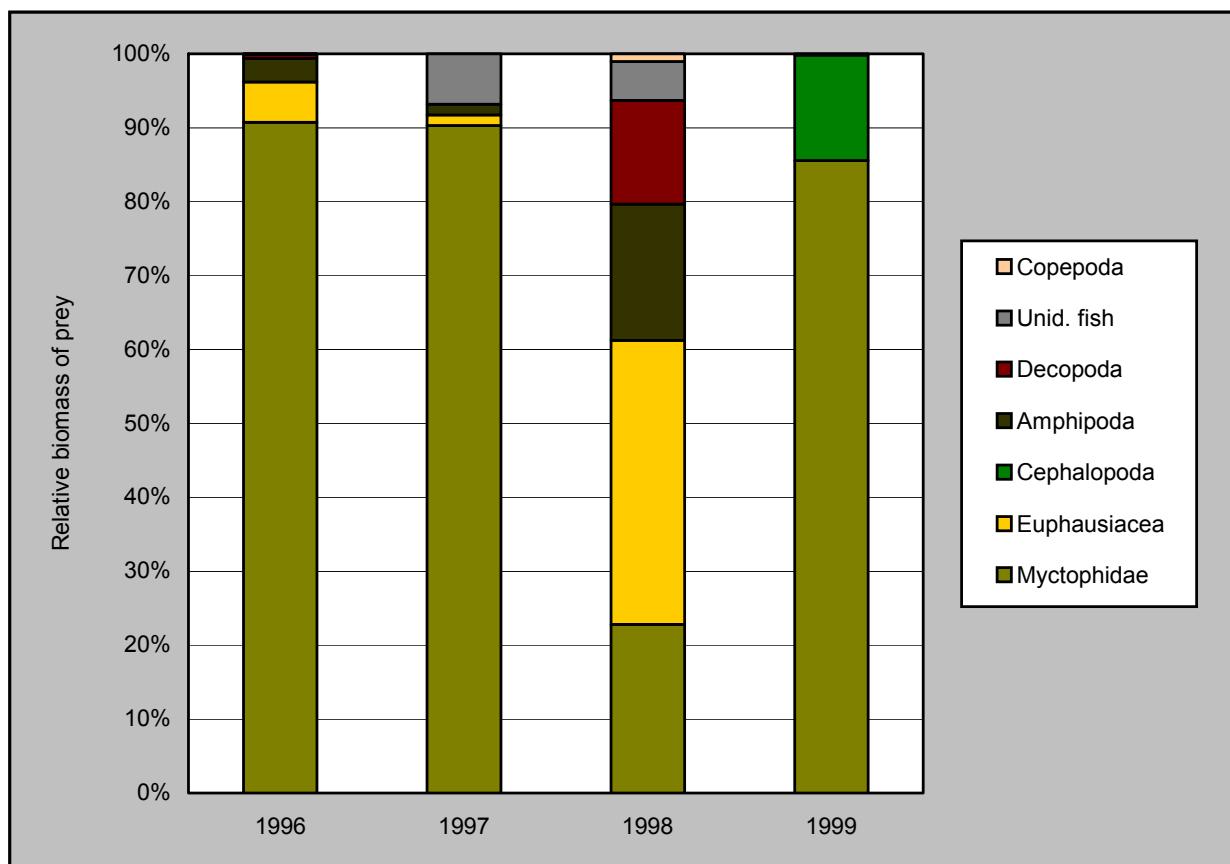


Figure 2. Relative biomass of prey in diets of Leach's storm-petrels at Buldir Island, Alaska.

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				
<i>Neocalanus cristatus</i>	<0.1		1.1	
Amphipoda				
Unid Amphipod				0.2
Hyperiidea				
<i>Hyperoche medusarum</i>	0.2			
<i>Parathemisto pacifica</i>	0.1			
Gammaridea				
Lysianassidae	2.9	1.5	17.5	
Unid. Gammarid			0.9	
Euphausiacea				
<i>Thysanoessa</i> 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				
<i>Stenobrachius leucopsarus</i>		33.7	22.8	
Myctophid, not <i>S. leucopsarus</i>		15.7		
Unid. Myctophidae ^a	90.7	40.9		85.6
Unid. fish		6.8	5.3	

^aMost, 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				
<i>Neocalanus cristatus</i>	6.7		20.0	
Amphipoda				
Unid. Amphipod				100.0
Hyperiidea				
<i>Hyperoche medusarum</i>	20.0			
<i>Parathemisto pacifica</i>	20.0			
Gammaridea				
<i>Lysianassidae</i>	20.0	43.8	60.0	
Euphausiacea				
<i>Thysanoessa</i> 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				
<i>Stenobrachius leucopsarus</i>		25.0	20.0	
Myctophid, not <i>S. leucopsarus</i>		6.3		
Unid. Myctophidae ^a	73.3	56.3		100.0
Unid. fish		6.3		20.0

^aMost, if not all, of the unidentified myctophids are probably *Stenobrachius leucopsarus*.

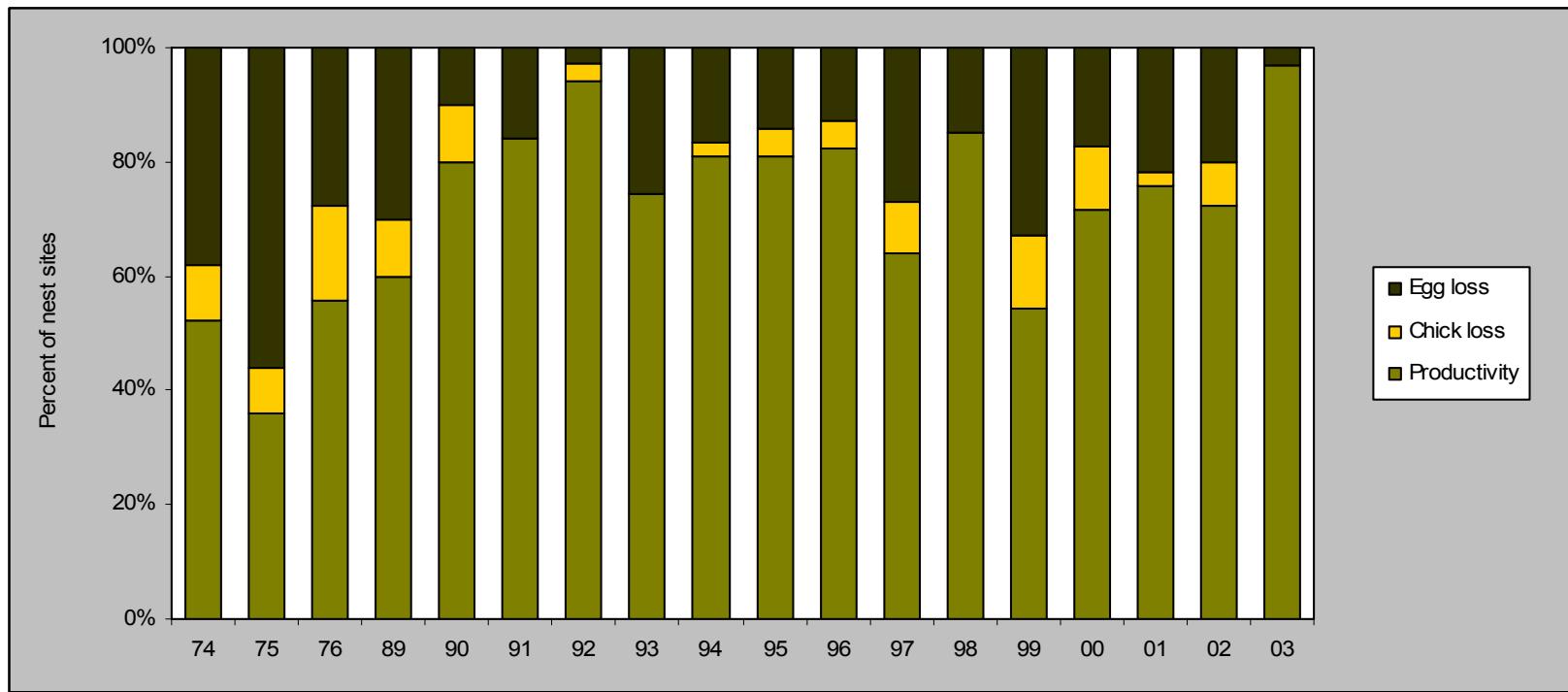


Figure 3. Reproductive performance of fork-tailed storm-petrels at Buldir Island, Alaska. These values represent the maximal reproductive potential. Actual values were undoubtedly lower. Egg loss=(C-D)/C; Chick loss=(D-E)/C; Productivity=E/C, where C=number of eggs, D=number of eggs hatched, E=number 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	1996	1997	1998	1999	2000	2001	2002	2003	
No. burrows w/ known contents (A)	69	71	113	232	285	287	294	249	297	280	308	277	282	265	304	189	285	116	
No. occupied burrows (B)	21	25	18	68	76	68	74	82	78	74	90	69	81	75	81	42	78	38	
No. eggs w/ known fate (C)	21	25	18	60	70	56	69	70	73	63	85	67	74	70	81	41	65	31	
eggs lost to:	disappearance	--	--	1	15	3	9	2	18	10	9	9	14	9	6	8	5	0	
abandonment	--	--	4	3	2	0	0	0	0	0	0	0	3	0	0	5	3	1	
breakage	--	--	0	0	2	0	0	0	2	0	2	1	2	17	0	0	5	0	
No. eggs remaining at last visit (unknown fate)	--	--	--	7	4	11	4	11	5	11	5	2	4	1	1	0	0	0	
No. chicks (D)	13	11	13	42	63	47	67	52	61	54	74	49	63	47	67	32	52	30	
chicks lost to:	disappearance ^a	--	--	0	2	3	0	0	0	0	2	3	1	0	5	7	1	3	0
death	--	--	3	4	4	0	2	0	2	1	1	5	0	4	2	0	2	0	
No. chicks potentially successful (E)	11	9	10	36	56	47	65	52	59	51	70	43	63	38	58	31	47	30	
chicks disapp. at unk. age or >55d	--	--	0	0	0	0	3	5	14	0	5	1	5	0	10	0	7	8	
chicks still present at last visit	11	9	10	36	56	47	62	47	45	51	65	42	58	38	48	31	40	20	
Occupancy rate (B/A)	0.30	0.35	0.16	0.29	0.27	0.24	0.25	0.33	0.26	0.26	0.29	0.25	0.21	0.28	0.27	0.22	0.27	0.33	
Hatching success (D/C)	0.62	0.44	0.72	0.70	0.90	0.84	0.97	0.74	0.84	0.86	0.87	0.73	0.85	0.67	0.83	0.78	0.80	0.97	
Fledging success (E/D) ^b	0.85	0.82	0.77	0.86	0.89	1.00	0.97	1.00	0.97	0.94	0.95	0.88	1.00	0.81	0.87	0.97	0.90	1.00	
Reproductive success (E/C) ^b	0.52	0.36	0.56	0.60	0.80	0.84	0.94	0.74	0.81	0.81	0.83	0.64	0.85	0.54	0.72	0.76	0.72	0.97	

^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.

Table 6. Productivity and burrow occupancy rates of fork-tailed storm-petrels at Buldir Island, Alaska, 2003.

Parameter	Plot						All plots	SD
	1	2	3	4	7	8		
No. burrows w/ known contents (A)	9	20	8	18	32	29	116	
No. occupied burrows (B)	2	8	2	9	6	11	38	
No. eggs w/ known fate (C)	2	6	2	9	4	8	31	
eggs lost to:								
disappearance	0	0	0	0	0	0	0	
abandonment	0	0	0	0	0	1	1	
breakage	0	0	0	0	0	0	0	
No. eggs remaining at last visit (unknown fate) ^a	0	0	0	0	0	0	0	
No. chicks (D)	2	6	2	9	4	7	30	
chicks lost to:								
disappearance ^b	0	0	0	0	0	0	0	
death	0	0	0	0	0	0	0	
No. chicks potentially successful (E)	2	6	2	9	4	7	30	
chicks disapp. at unk. age or >55d	0	1	1	4	0	2	8	
chicks still present at last visit	2	5	1	5	4	5	20	
Occupancy rate (B/A)	0.22	0.40	0.25	0.50	0.19	0.38	0.33	0.06
Hatching success (D/C)	1.00	1.00	1.00	1.00	1.00	0.88	0.97	0.03
Fledging success (E/D) ^c	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Reproductive success (E/C) ^c	1.00	1.00	1.00	1.00	1.00	0.88	0.97	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 those that disappeared before 1 Aug (earliest date we expected fledging).

^c This value represents the maximum reproductive potential. Actual values were undoubtedly lower.

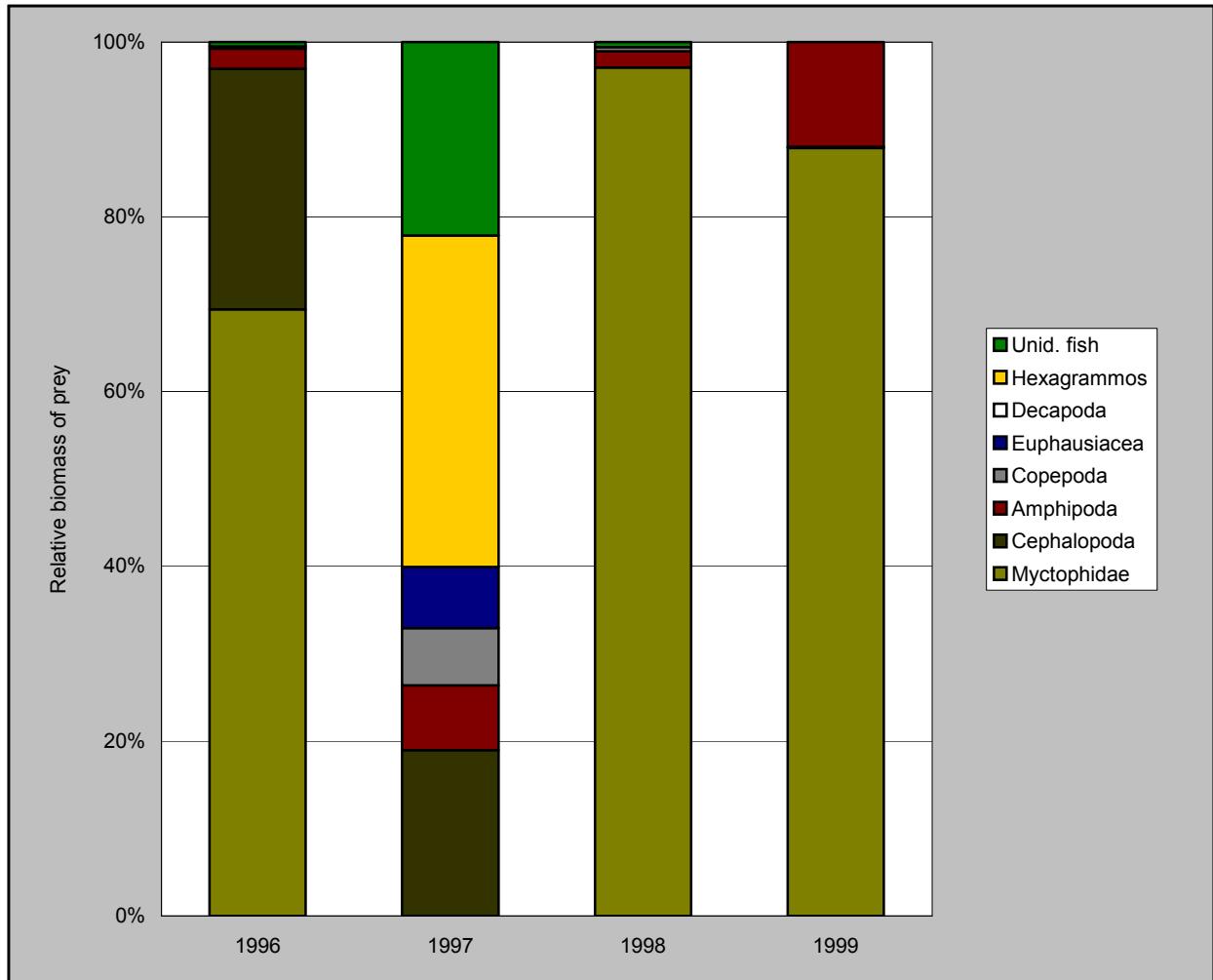


Figure 4. Relative biomass of prey in diets of fork-tailed storm-petrels at Buldir Island, Alaska.

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				
<i>Neocalanus plumchrus</i>	0.2	4.2	0.5	
Amphipoda				
Unid. Amphipod				12.0
Hyperiidea				
<i>Hyperoche medusarum</i>	<0.1			
<i>Parathemisto pacifica</i>	0.1			
Gammaridea				
<i>Lysianassidae</i>	2.3	4.7	1.9	
Euphausiacea				
<i>Thysanoessa</i> spp.		4.4		
Decapoda				
Shrimp zoea	<0.1			
Fish				
Myctophidae				
<i>Stenobrachius leucopsarus</i>		8.1	97.1	
Unid. Myctophidae ^a	69.4	28.2		87.9
<i>Hexagrammos</i> spp.		24.2		
Unid. fish	0.5	14.1	0.6	

^aMost, 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				
<i>Neocalanus plumchrus</i>	15.4	28.6	16.7	
Amphipoda				
Unid. Amphipod				50.0
Hyperiidea				
<i>Hyperoche medusarum</i>	7.7			
<i>Parathemisto pacifica</i>	15.4			
Gammaridea				
Lysianassidae	46.2	57.1	50.0	
Euphausiacea				
<i>Thysanoessa</i> spp.		14.3		
Decapoda				
Shrimp zoea	7.7			
Unid. Crustacea		14.3		
Fish				
Myctophidae				
<i>Stenobrachius leucopsarus</i>		14.3	100.0	
Unid. Myctophidae ^a	76.9	42.9		100.0
<i>Hexagrammos</i> spp.		14.3		
Unid. fish	7.7	28.6		
(Plastic - not prey)		14.3	33.3	

^aMost, if not all, of the unidentified myctophids are probably *Stenobrachius leucopsarus*.

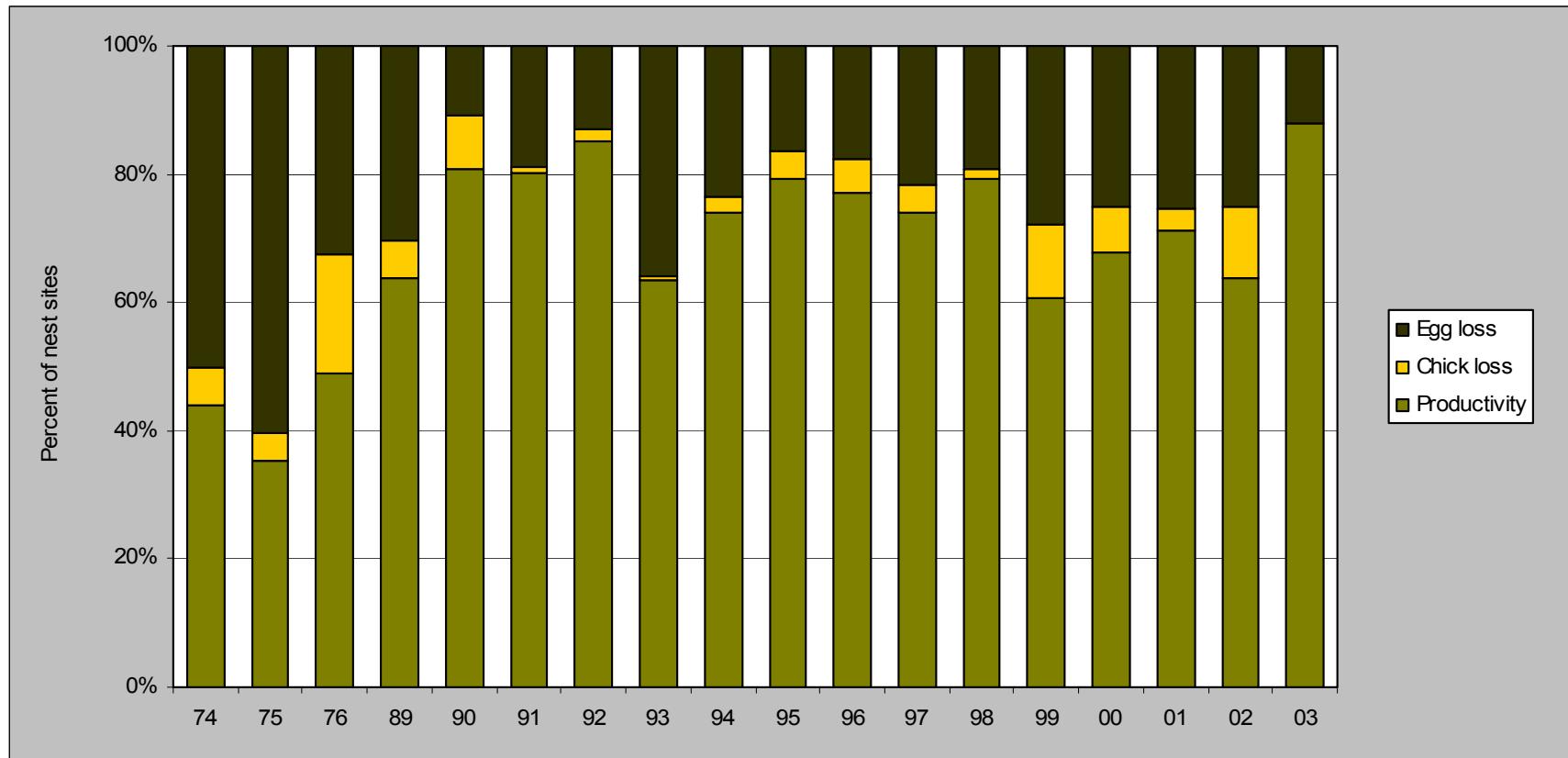


Figure 5. Reproductive performance of storm-petrels (Leach's, fork-tailed and unknown species) at Buldir Island, Alaska. These values represent the maximal reproductive potential. Actual values were undoubtedly lower. Egg loss=(C-D)/C; Chick loss=(D-E)/C; Productivity=E/C, where C=number of eggs, D=number 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	1996	1997	1998	1999	2000	2001	2002	2003
No. burrows w/ known contents (A)	69	71	113	232	285	287	294	249	297	280	308	277	282	265	304	189	285	116
No. occupied burrows (B)	50	48	49	160	181	163	180	170	183	168	190	168	149	182	164	103	191	94
No. eggs w/ known fate (C)	50	48	49	132	146	132	122	162	166	139	170	153	125	150	164	94	179	75
eggs lost to:	--	--	--	28	10	25	16	37	27	18	26	25	14	11	18	19	19	3
disappearance	--	--	--	7	4	0	0	1	0	0	0	5	0	0	10	5	4	5
abandonment	--	--	--	5	2	0	0	0	12	5	4	3	10	31	5	0	19	1
breakage	--	--	--	26	29	30	57	27	17	28	17	9	20	16	8	1	3	0
No. eggs remaining at last visit (unknown fate) ^a	--	--	--	26	29	30	57	27	17	28	17	9	20	16	8	1	3	0
No. chicks (D)	25	19	33	92	130	107	106	104	127	116	140	120	101	108	123	70	134	66
chicks lost to:	--	--	0	2	6	0	0	0	0	4	7	1	0	7	10	3	12	0
disappearance ^b	--	--	9	6	8	1	2	1	4	2	2	6	2	13	2	0	8	0
No. chicks potentially successful (E)	22	17	24	84	118	106	104	103	123	110	131	113	99	91	111	67	114	66
chicks disapp. at unk. age or >55d	--	--	0	0	1	0	3	6	22	0	5	2	5	0	10	0	7	8
chicks still present at last visit	22	17	24	84	117	106	101	97	101	110	126	111	91	91	101	67	107	58
Occupancy rate (B/A)	0.72	0.68	0.43	0.69	0.64	0.57	0.61	0.68	0.62	0.60	0.62	0.61	0.53	0.69	0.54	0.54	0.67	0.81
Hatching success (D/C)	0.50	0.40	0.67	0.70	0.89	0.81	0.87	0.64	0.77	0.83	0.82	0.78	0.81	0.72	0.75	0.75	0.75	0.88
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	0.94	0.94	0.98	0.84	0.90	0.96	0.85	1.00
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	0.77	0.74	0.79	0.61	0.68	0.71	0.64	0.88

^a Eggs still present at last check, although apparently viable, are not included in analysis.

^b Chicks known to be <55 d when they disappeared or those 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, 2003.

Parameter	Plot						All plots	SD
	1	2	3	4	7	8		
No. burrows w/ known contents (A)	9	20	8	18	32	29	116	
No. occupied burrows (B)	6	17	6	14	29	22	94	
No. eggs w/ known fate (C)	6	14	3	13	22	17	75	
eggs lost to:								
disappearance	0	1	0	2	0	0	3	
abandonment	0	2	0	0	1	2	5	
breakage	0	0	0	0	1	0	1	
No. eggs remaining at last visit (unknown fate) ^a	0	0	0	0	0	0	0	
No. chicks (D)	6	11	3	11	20	15	66	
chicks lost to:								
disappearance ^b	0	0	0	0	0	0	0	
death	0	0	0	0	0	0	0	
No. chicks potentially successful (E)	6	11	3	11	20	15	66	
chicks disapp. at unk. age or >55d	0	1	1	4	0	2	8	
chicks still present at last visit	6	10	2	7	20	13	58	
Occupancy rate (B/A)	0.67	0.85	0.75	0.78	0.91	0.76	0.81	0.08
Hatching success (D/C)	1.00	0.79	1.00	0.85	0.91	0.88	0.88	0.08
Fledging success (E/D) ^c	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Reproductive success (E/C) ^c	1.00	0.79	1.00	0.85	0.91	0.88	0.88	0.08

^a Eggs still present at last check, although apparently viable, are 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.

Parameter	1974 ^a	1989	1990	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Total no. nests (A) date ^b	53 5 Jun	37 16 Jun	34 13 Aug	35 11 Jun	21 12 Jun	28 15 Jun	14 13 Jun	17 1 Aug	22 25 May	29 22 Jun	24 24 Jun	48 6 June	64 10 Jun	66 16 Jun	73 13 Jun
Total no. chicks (B) date ^c	23 ^d 19 Aug	-- --	61 13 Aug	25 2 Aug	13 19 Aug	36 9 Aug	17 10 Aug	13 5 Aug	24 10 Aug	18 7 Aug	31 12 Aug	52 4 Aug	55 29 Jul	59 5 Aug	39 1 Aug
No. large chicks in nest ^d :															
0	--	--	7	25	14	10	5	9	13	14	7	3	18	0	26
1	--	--	4	0	3	6	3	3	0	0	2	8	9	9	8
2	--	--	12	5	2	6	4	5	3	6	8	10	18	19	11
3	--	--	11	5	2	6	2	0	6	2	5	0	3	4	3
No. nests w/ chicks (C)	--	--	27	10	7	18	9	8	9	8	15	25	33	32	22
Brood size (B/C) mean	--	--	2.3	2.5	1.9	2.0	1.9	1.6	2.7	2.3	2.2	2.1	1.8	1.8	1.7
SD	--	--	0.7	0.5	0.9	0.8	0.8	0.5	0.5	0.5	0.7	0.9	0.6	0.6	0.7
%nests w/ chicks ((C/A)x100)	68.8 ^d	--	79.4	28.6	33.3	64.3	64.3	47.1	40.9	27.6	62.5	52.1	51.6	48.5	45.2
Productivity ^e (B/A)	1.4 ^d	--	1.8	0.9	0.6	1.3	1.2	0.8	1.1	0.6	1.3	1.1	0.9	0.9	0.5

^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 Date when the most nests or chicks were counted.

^c Date when the most chicks were counted.

^d Large chick numbers are from counts in early to mid August.

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

Parameter	2003
Total no. nests ^a (A)	4
date ^b	19 Jun
Total no. chicks (B)	5
date ^c	25 Jun
No. large chicks in nest ^d :	
0	1
1	1
2	2
3	0
No. nests w/ chicks (C)	3
Brood size (B/C) mean	1.67
SD	0.6
%nests w/ chicks	75
((C/A)x100)	
Productivity ^e (B/A)	1.25

^a Observers counted cormorant nests along 2 transects: Main Talus to Petrel Valley, and Petrel Valley to Kittiwake Lane.

^b Date when the most nests were counted.

^c Date when the most chicks were counted.

^d Large chick numbers are from counts in early to mid August.

^e Number of chicks present per nest, including empty nests.

Table 13. Pelagic cormorant productivity at Buldir Island, Alaska in 2003.

Date	No. nests	No. nests containing X chicks					No. nests	
		0	1+	2+	3+	4+	w/ chick	no. chicks
13 Jun	73	73	0	0	0	0	0	0
19 Jun	65	65	0	0	0	0	0	0
28 Jun	64	64	0	0	0	0	0	0
9 Jul	55	53	2	0	0	0	2	2
19 Jul	50	36	9	3	2	0	14	21
25 Jul	46	26	8	10	2	0	20	34
1 Aug	48	26	8	11	3	0	22	39
31 Aug	44	30	5	5	4	0	14	27

Table 14. Red-faced cormorant productivity at Buldir Island, Alaska in 2003.

Date	No. nests	No. nests containing X chicks					No. nests	
		0	1+	2+	3+	4+	w/ chick	no. chicks
13 Jun	1	1	0	0	0	0	0	0
19 Jun	4	4	0	0	0	0	0	0
28 Jun	4	4	0	0	0	0	0	0
9 Jul	4	4	0	0	0	0	0	0
19 Jul	3	0	2	1	0	0	3	4
25 Jul	3	0	1	2	0	0	3	5
1 Aug	3	1	0	2	0	0	2	4
31 Aug	3	3	0	0	0	0	0	0

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
Total no. nests (A)	--	209	199	180	133	175	88	75	20	54	--	38	23
No. eggs in nest:													
0	0	49	66	49	82	40	63	18	17	11	--	9	0
1	1	28	26	15	5	15	6	8	0	3	--	2	2
2	10	48	35	40	20	35	10	26	2	10	--	4	1
3	56	84	72	75	26	85	9	22	1	30	--	23	13
4	0	0	0	1	0	0	0	0	0	0	--	0	0
Clutch size: \bar{x} 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
n (B)	67	160	133	131	51	135	25	56	3	43	--	29	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
Max. no. eggs (C) ^b	--	376	312	324	123	340	53	126	7	113	--	81	53
Maximum no. chicks seen (D)	--	122	35	49	34	83	28	28	2	17	--	33	22
Chicks seen on last visit before fledging (E)	--	89	8	48	14	34	15	9	0	12	--	15	19
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
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
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
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
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

^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
No. nests (A)	47	30	20	28	--	37	23
No. nests w/ ≥ 1 egg (B)	10	26	3	24	--	31	22
No. eggs (C)	22	58	7	63	--	89	56
No. nests ≥ 1 chick (D)	8	13	1	10	--	26	20
No. chicks (E)	14	21	2	18	--	57	38
Laying success (B/A)	0.21	0.87	0.15	0.86	--	0.84	0.96
Nesting success (D/B)	0.80	0.50	33.3	0.42	--	0.84	0.91
Hatching success (E/C)	0.64	0.36	0.29	0.29	--	0.64	0.68
Mean hatch date	11 July	2 July	23 Jun	23 Jun	--	21 Jun	-- ^a
n	5	13	1	7	--	14	--
SD	2.2	3.4	--	6.2	--	6.4	--

^aHatch dates not calculated; chicks were present on the first visit.

Table 17. Clutch size of glaucous-winged gulls at Buldir Island, Alaska in 2003.

Date	No. nests	No. nests containing X eggs				Total No. eggs	No. chicks
		0	1	2	3		
< 13 Jun ^a	21	0	3	4	14	53	
13 Jun	21	0	2	1	13	43	7
19 Jun	23	13	3	0	7	24	19
28 Jun	23	21	1	1	0	3	22
19 Jul	23	23	0	0	0	0	19

^aThese data estimated on basis of chicks present on first check (13 Jun).

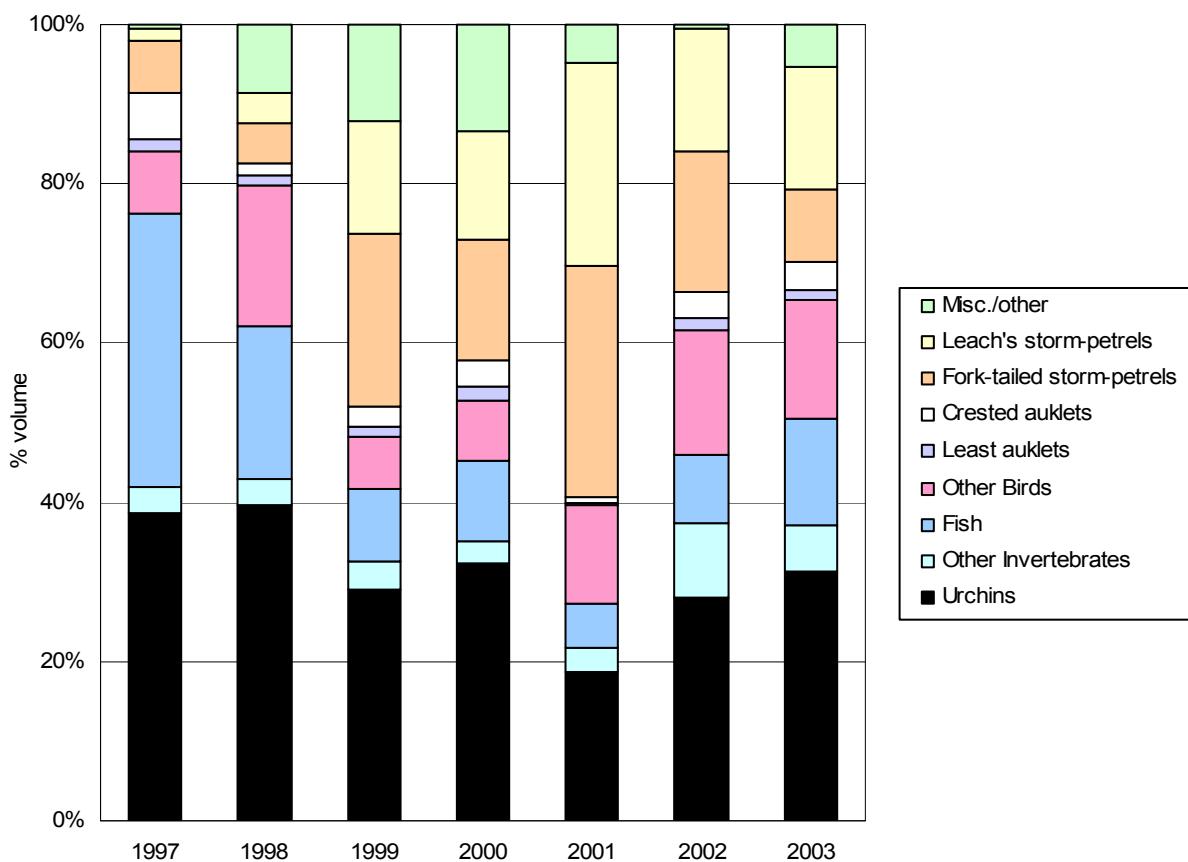


Figure 6. Percent volume of food items in regurgitated pellets of glaucous-winged gulls at Buldir Island, Alaska. Composite value for Invertebrates does not include Urchins. Composite value for Birds is inclusive of all species except crested auklet, least auklet, fork-tailed storm-petrel, and Leach's 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
Invertebrates^b	1.9	46.2	49.5	38.4	42.3	28.1	46.6	47.4
sea urchin	1.1	39.9	42.8	33.5	37.3	22.4	31.6	35.9
blue mussel	--	3.2	2.4	2.4	2.9	2.1	3.2	2.4
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
chiton	--	--	1.9	0.2	0.4	--	0.8	--
crab	--	0.6	0.5	0.2	0.4	0.4	--	0.3
unid. bivalve	--	0.6	0.5	0.4	--	0.7	--	--
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
<10 cm	--	8.9	10.0	6.5	2.5	1.8	6.1	12.1
10-20 cm	--	12.0	9.5	4.2	6.1	3.9	6.1	0.2
>20 cm	--	15.2	1.9	0.6	3.6	0.7	1.6	1.5
unknown size	--	--	--	--	--	--	--	4.5
Birds	79.2	24.1	31.9	48.5	44.8	70.1	60.7	48.9
crested auklet	2.9	6.3	1.0	2.4	3.6	0.7	4.0	3.8
least auklet	1.4	1.3	1.4	1.4	1.8	0.4	1.6	1.2
whiskered auklet	--	--	--	0.2	0.4	0.4	--	--
parakeet auklet	--	--	0.5	0.2	2.5	1.1	1.6	2.7
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
unid. sm. Auklet	--	1.3	--	--	0.7	--	--	0.2
unid. med. Auklet	--	1.3	--	0.4	--	--	--	--
unid. auklet	1.4	3.8	0.5	0.4	0.7	0.7	3.6	--
fork-tailed storm-petrel	40.0	7.0	5.7	22.2	16.1	29.5	18.2	9.1
Leach's storm-petrel	20.0	1.3	3.8	15.4	14.3	26.3	16.2	16.1
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
tufted puffin	0.2	--	--	--	--	--	0.8	--
unid. puffin	--	--	--	--	--	--	--	0.2
Aleutian Canada gosling	--	--	--	0.2	0.4	--	0.8	--
Aleutian Canada eggs	--	--	--	--	--	--	--	1.2
unid. sm. bird	0.3	0.6	13.3	1.4	1.1	5.3	0.8	6.4
unid. bird eggs	1.7	--	--	2.0	--	1.4	4.0	1.2
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
terrestrial vegetation	2.5	--	--	0.4	2.2	--	--	0.5
unid. marine algae	--	1.3	5.7	15.8	15.1	3.9	2.0	7.4
pebbles	0.8	--	4.3	1.8	1.4	1.9	0.8	0.3
sea lion hair	3.5	--	--	--	--	--	--	--
Plastic	--	--	--	--	2.9	--	2.0	0.2

^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
Invertebrates^a	42.0	42.9	32.6	35.1	21.7	37.3	37.1
sea urchin	38.7	39.6	29.1	32.3	18.6	28.2	31.2
blue mussel	2.3	1.8	1.9	1.5	1.0	2.2	0.8
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
chiton	--	<0.1	0.2	0.1	--	0.6	--
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
<10 cm	7.4	9.9	4.8	1.6	1.0	4.8	9.4
10-20 cm	11.7	5.1	3.8	5.2	3.9	3.4	0.1
>20 cm	15.2	4.3	0.4	3.2	0.7	0.6	1.3
unidentified	--	--	--	--	--	--	2.4
Birds	23.1	29.2	46.2	41.5	67.9	53.6	44.4
crested auklet	6.0	1.4	2.4	3.3	0.7	3.5	3.6
least auklet	1.3	1.4	1.4	1.8	0.4	1.4	1.2
whiskered auklet	--	--	0.2	0.4	0.4	--	--
parakeet auklet	--	0.5	0.2	2.5	1.1	1.4	2.6
Cassin's auklet	--	0.5	--	0.4	--	--	0.8
Ancient murrelet	--	0.5	0.2	2.7	4.0	6.2	2.0
unid. sm. Auklet ^c	0.3	--	--	<0.1	--	--	--
unid. med. Auklet ^c	0.6	--	0.4	--	--	--	--
unid. auklet	4.4	0.5	0.4	0.7	0.7	3.6	--
fork-tailed storm-petrel	6.7	5.2	21.7	15.1	29.0	17.5	9.0
Leach's storm-petrel	1.3	3.8	14.2	13.6	25.5	15.6	15.5
unid. storm-petrel	1.9	3.8	2.0	--	--	1.3	1.4
black-legged kittiwake	--	--	--	--	--	0.4	--
unidentified kittiwake	--	--	--	--	--	--	1.1
tufted puffin	--	--	--	--	--	1.0	--
unidentified puffin	--	--	--	--	--	--	0.1
Aleutian Canada 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
gull egg	--	--	--	--	--	--	1.4
goose egg	--	--	--	--	--	--	1.0
unid. bird eggs	--	0.8	1.6	--	1.2	0.5	0.4
Miscellaneous	0.6	8.5	12.0	13.4	4.9	0.4	5.2
terrestrial vegetation	--	--	0.2	1.1	--	--	0.1
unid. marine algae	0.6	4.9	11.1	11.6	2.2	0.2	5.0
pebbles	--	3.6	0.7	0.6	2.7	<0.1	0.1
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 660 regurgitated pellets of glaucous-winged gulls along the north shore of Buldir Island, Alaska, 4 June-29 July 2003.

Food item	no. samples	min. no. birds/orgs.	% occurrence ^a
Invertebrates	313	313	47.4
sea urchin	237	237	35.9
blue mussel	16	16	2.4
snail	3	3	0.5
limpet	44	44	6.7
crab	2	2	0.3
unid. shellfish	11	11	1.7
Fish^b	121	121	18.3
<10 cm	80	80	12.1
10-20 cm	1	1	0.2
>20 cm	10	10	1.5
Unk. size	30	30	4.5
Birds	323	323	48.9
crested auklet	25	25	3.8
least auklet	8	8	1.2
parakeet auklet	18	18	2.7
cassin's auklet	6	6	0.9
Least or whiskered auklet	1	1	0.2
Ancient murrelet	13	13	2.0
unid. kittiwake	8	8	1.2
fork-tailed storm-petrel	60	60	9.1
Leach's storm-petrel	106	106	16.1
unid. sm. bird	42	42	6.4
unid. storm-petrel	10	10	1.5
unid. puffin	1	1	0.2
gull egg	9	9	1.4
goose egg	8	8	1.2
unid. egg	8	8	1.2
Miscellaneous	55	55	8.3
plant material	3	3	0.5
kelp/sea weed	49	49	7.4
pebbles	2	2	0.3
plastic	1	1	0.2

^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

^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

Table 22. Hatching dates of black-legged kittiwake nests by plot at Buldir Island, Alaska, 2003^a.

Plot	July																																		
	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				
34c								1																								2			
36									1																										
38a																																			
38b										2																									
38c																																			
39d																																			
39e																																			
40a									3																										
40b		1								2									3																
42																																			
45a									1																										
45b										1																									
46		1								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.

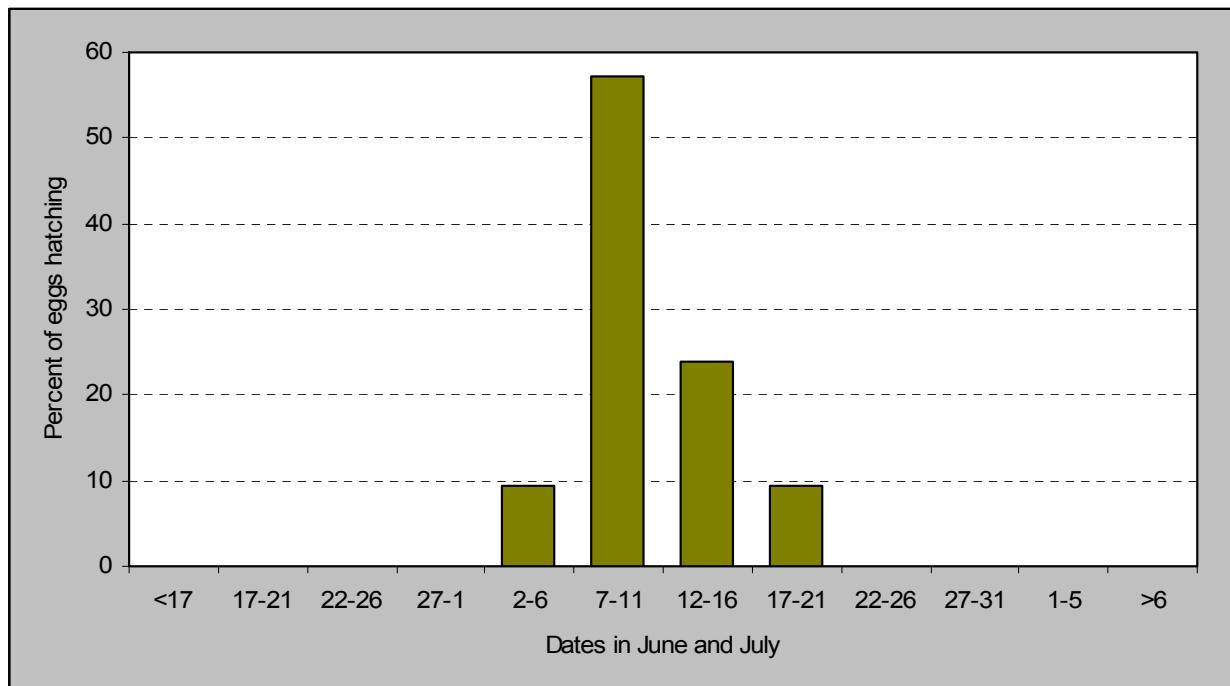


Figure 7. Hatching chronology of black-legged kittiwakes at Buldir Island, Alaska in 2003 (n = 21).

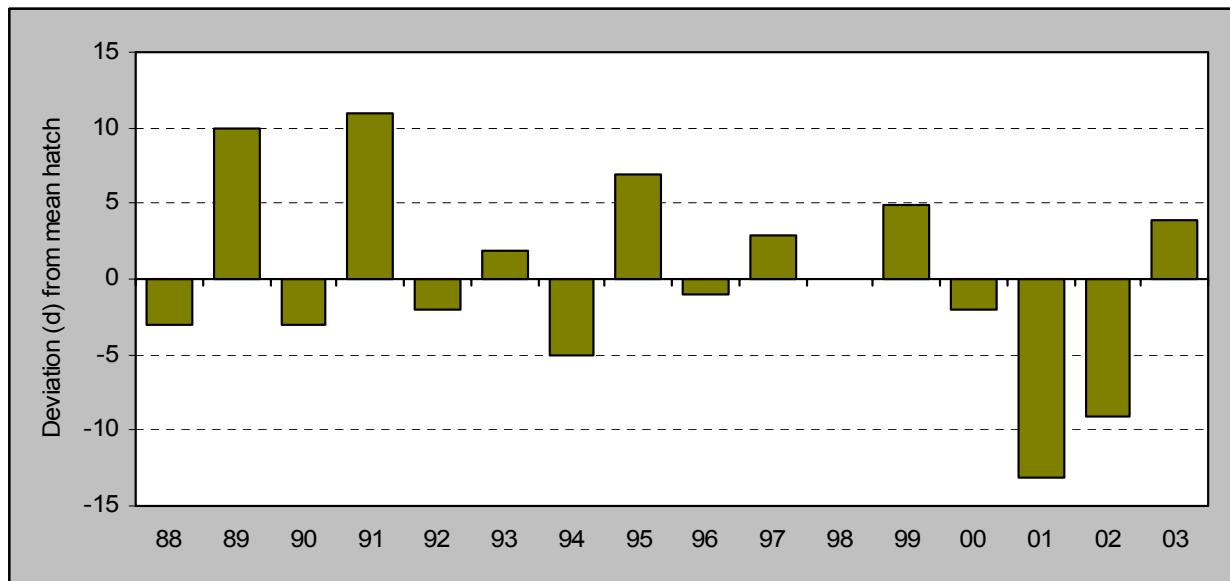


Figure 8. Yearly hatch date deviation (from the 1988-2003 average of 17 July) for black-legged kittiwakes at Buldir Island, Alaska. Numbers below the mean indicate hatch dates earlier, positive numbers indicate hatch dates later.

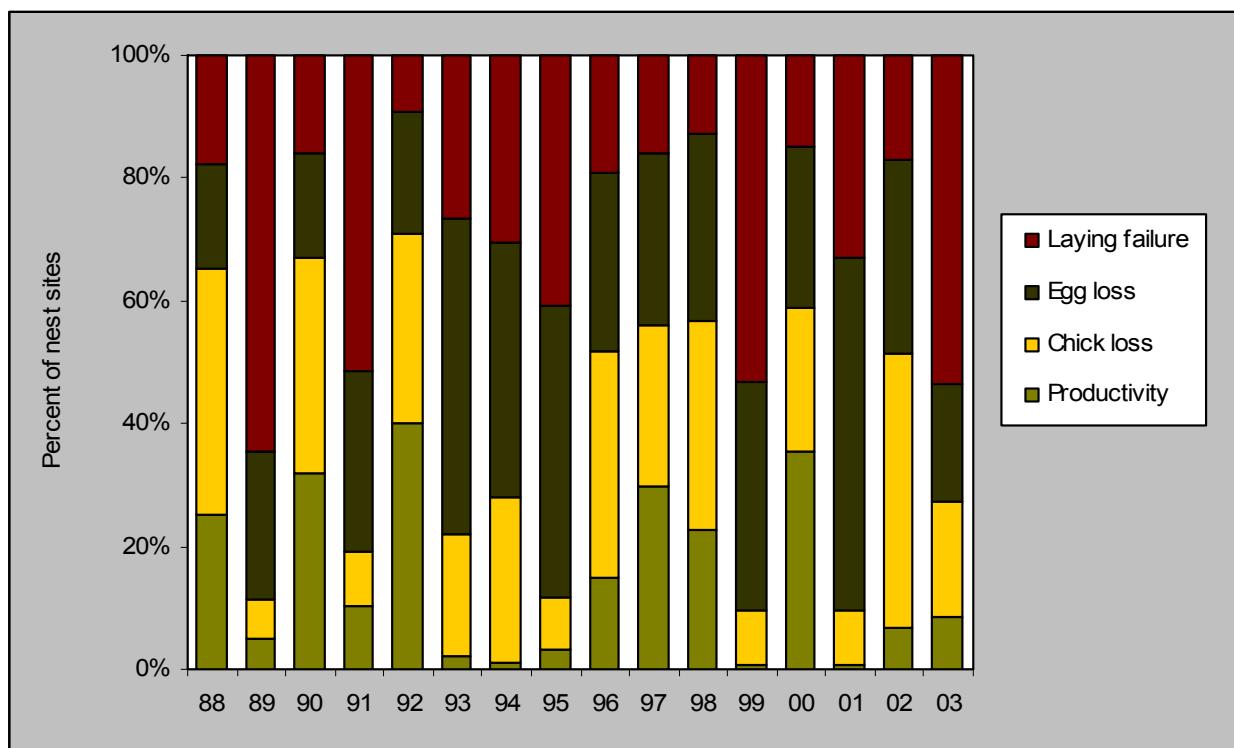


Figure 9. Reproductive performance of black-legged kittiwakes at Buldir Island, Alaska. Laying Failure=(A-B)/A; Egg Loss=(B-D)/A; Chick Loss=(D-F)/A; Productivity=F/A, where A=total number of nests; B=number of nests with ≥ 1 egg; D=number of nests with ≥ 1 chick; F=number of nests with ≥ 1 fledged chick

Table 23 . 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

^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 24. Black-legged kittiwake clutch sizes at Buldir Island, Alaska.

	1976 ^a	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
mean	1.61	1.78	1.22	1.76	1.35	1.79	1.58	1.66	1.41	1.69	1.73	1.75	1.49	1.79	--	1.79	1.51
n ^b	74	462	220	761	350	462	391	323	213	344	415	244	237	324	--	299	99
no. eggs/nest																	
0	--	--	--	--	--	--	--	--	145	82	78	36	126	48	--	51	114
1	--	--	--	--	--	--	--	--	126	107	111	64	57	59	--	54	49
2	--	--	--	--	--	--	--	--	87	236	304	178	54	216	--	193	50
3	--	--	--	--	--	--	--	--	0	1	0	2	0	1	--	1	0

^a Data from Byrd and Day (1986).

^b Nest sites used as sample units.

Table 25. Reproductive performance of black-legged kittiwakes on index plot at Buldir Island, Alaska, in 2003.

Parameter	Kittiwake Lane Plots								total	n	mean	SD
	34c	36	39D	39e	40a	40b	45a	45b				
total nests (A)	23	22	36	32	26	33	23	18	213			
no. of nests with ≥ 1 egg (B)	10	9	8	8	16	19	19	10	99			
total eggs (C)	15	13	15	12	25	31	27	11	149			
no. of nests with ≥ 1 chick (D)	8	8	2	0	12	13	11	4	58			
total chicks (E)	9	10	4	0	14	14	12	4	67			
no. of nests where ≥ 1 chick fledged (F)	2	1	0	0	6	2	4	3	18			
total chicks fledged (G)	2	1	0	0	6	2	4	3	18			
nests with 1 egg	5	5	1	4	7	7	11	9	49			
nests with 2 eggs	5	4	7	4	9	12	8	1	50			
nests with 3 eggs	0	0	0	0	0	0	0	0	0			
laying succ. (B/A)	0.43	0.41	0.22	0.25	0.62	0.58	0.83	0.56		8	0.46	0.08
clutch size (C/B)	1.50	1.44	1.86	1.50	1.56	1.63	1.42	1.10		8	1.51	0.06
nesting succ. (D/B)	0.80	0.89	0.25	0.00	0.75	0.68	0.58	0.40		8	0.59	0.08
hatching success (E/C)	0.60	0.77	0.27	0.00	0.56	0.45	0.44	0.36		8	0.45	0.06
chick succ. (G/E)	0.22	0.10	0.00	0.00	0.43	0.14	0.33	0.75		8	0.27	0.07
egg success (G/C)	0.13	0.08	0.00	0.00	0.24	0.06	0.15	0.27		8	0.12	0.03
fledging success (F/D)	0.25	0.13	0.00	0.00	0.50	0.15	0.36	0.75		8	0.31	0.07
reproductive success (F/B)	0.20	0.11	0.00	0.00	0.38	0.11	0.21	0.30		8	0.18	0.05
overall productivity (F/A)	0.20	0.05	0.00	0.00	0.23	0.06	0.17	0.17		8	0.08	0.03

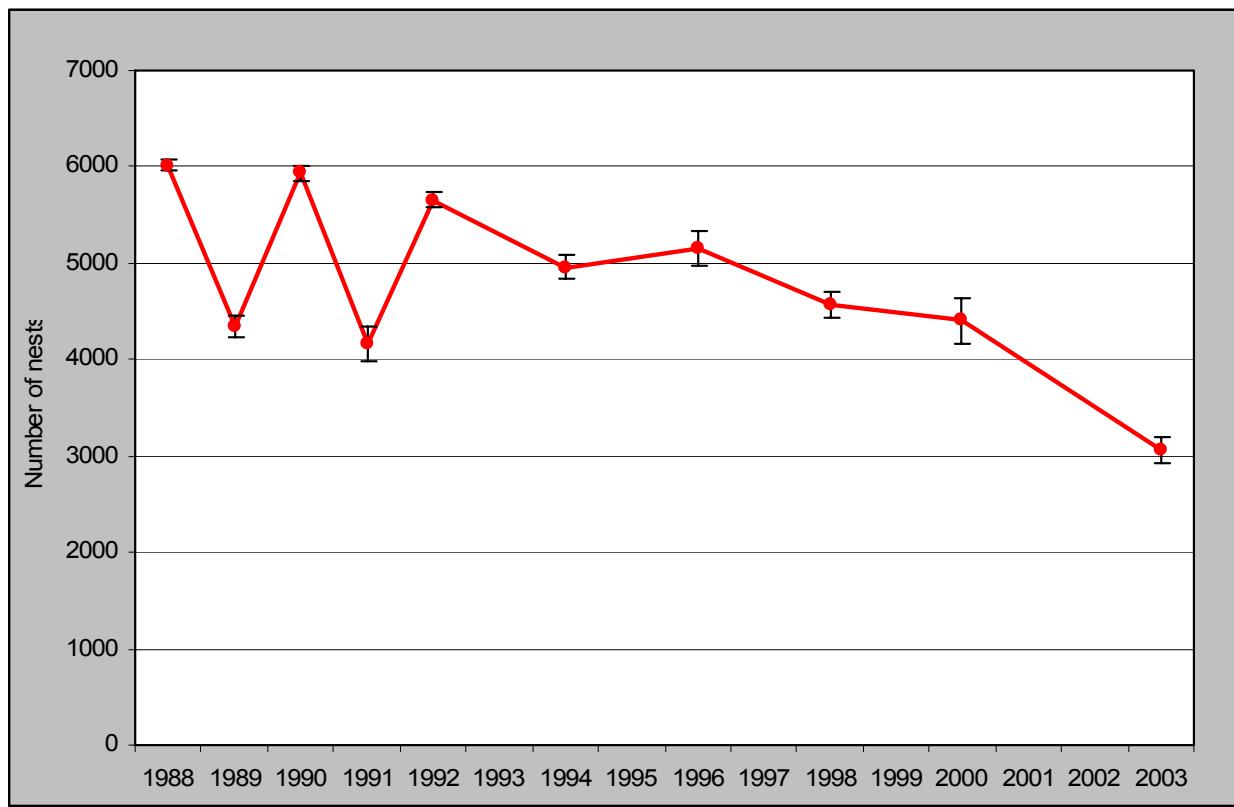


Figure 10. Counts of black-legged kittiwake nests on index plots at Buldir Island, Alaska. Error bars represent the standard deviation of counts in each year.

Table 26. 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 27. 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 28. Numbers of black-legged kittiwake nests on index plots at Buldir Island, Alaska in 2003.

Plot (segment)	Plot				mean	SD	max.
	1	2	3	4			
The Dip							
1	0	0	0	0	0.0	0.0	0
2	1	1	0	0	0.5	0.6	1
3	47	37	24	30	34.5	9.9	47
4	63	86	64	70	70.8	10.6	86
5	128	154	128	129	134.8	12.8	154
6	384	361	348	377	367.5	16.2	384
7	41	78	77	78	68.5	18.3	78
Total	664	717	641	684	676.5	32.2	717
Kittiwake Lane							
15(1)	243	241	305	234	255.8	33.1	305
16(2)	357	355	328	228	317.0	60.8	357
17(3)	329	287	298	275	297.3	23.2	329
18(4)	306	191	270	251	254.5	48.1	306
19(5)	153	143	167	172	158.8	13.2	172
20(6)	120	100	102	83	101.3	15.1	120
21(7)	220	190	189	139	184.5	33.6	220
22(8)	193	209	239	212	213.3	19.1	239
23(9)	115	178	171	148	153.0	28.4	178
24(10)	85	100	94	81	90.0	8.6	100
25(11)	74	63	71	68	69.0	4.7	74
26(12)	97	122	145	121	121.3	19.6	145
27(13)	80	60	97	105	85.5	19.9	105
28(14)	75	56	63	62	64.0	8.0	75
29(15)	11	16	20	22	17.3	4.9	22
KWLE ^a	1235	1074	1201	988	1124.5	114.4	1235
KWLW	730	1237	1358	1213	1134.5	277.0	1358
KWL total	2458	2311	2559	2201	2382.3	158.0	2559
Index plot total ^b	3122	3028	3200	2885	3058.8	135.5	3200

^a KWLE is Kittiwake Lane East (plots 15-18), KWLW is Kittiwake Lane West (plots 19-29).

^b Consists of all plots at The Dip and Kittiwake Lane combined.

Table 29. Numbers of black-legged kittiwakes on index plots at Buldir Island, Alaska in 2003.

Plot (segment)	Plot				mean	SD	max
	1	2	3	4			
The Dip							
1	0	0	0	0	0.0	0.0	0
2	2	0	0	0	0.5	1.0	2
3	58	44	28	28	39.5	14.5	58
4	91	105	31	30	64.3	39.4	105
5	164	210	122	104	150.0	47.2	210
6	451	456	345	490	435.5	62.8	490
7	62	88	39	53	60.5	20.6	88
Total	828	903	565	705	750.3	148.0	903
Kittiwake Lane							
15(1)	329	299	359	251	309.5	46.1	359
16(2)	500	465	439	294	424.5	90.5	500
17(3)	406	347	375	291	354.8	48.9	406
18(4)	355	298	381	244	319.5	61.1	381
19(5)	227	202	227	165	205.3	29.3	227
20(6)	200	189	179	87	163.8	51.9	200
21(7)	330	307	321	191	287.3	64.9	330
22(8)	525	291	315	173	326.0	146.5	525
23(9)	288	252	236	172	237.0	48.5	288
24(10)	195	152	129	89	141.3	44.3	195
25(11)	171	96	105	80	113.0	40.0	171
26(12)	224	177	184	95	170.0	54.1	224
27(13)	142	136	158	111	136.8	19.5	158
28(14)	115	38	96	27	69.0	43.1	115
29(15)	13	5	15	4	9.3	5.6	15
KWLE ^a	1590	1409	1554	1080	1408.3	232.4	1590.0
KWLW	2430	1845	1965	1194	1858.5	509.8	2430
KWL total	4020	3254	3519	2274	3266.8	734.1	4020
Index plot total ^b	4848	4157	4085	2979	4017.0	772.9	4848

^a KWLE is Kittiwake Lane East (plots 15-18), KWLW is Kittiwake Lane West (plots 19-29).

^b Consists of all plots at The Dip and Kittiwake Lane combined.

Table 30. 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 31. Black-legged kittiwake nest counts by sub-area at Middle Rock, Buldir Island, Alaska (Middle Rock was not counted in 2003).

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

^aPartial count, not for comparison.

Table 32. Black-legged kittiwake counts by sub-area at Middle Rock, Buldir Island, Alaska (Middle Rock was not counted in 2003).

Segment (Plot)	1974	1975	1976	1984	1988	1989	1990	1991	1992	1994	1996	1998	2001
I	--	--	--	--	206	342	211	229	239	--	161	125	136
II	--	--	--	--	135	225	128	111	120	--	96	111	139
III	--	--	--	--	241	175	125	68	106	--	40	102	0
IV	--	--	--	--	210	97	80	85	34	--	92	51	30
V	--	--	--	--	135	402	232	263	211	--	201	210	109
VI	--	--	--	--	300	296	203	309	236	--	241	271	94
VII	--	--	--	--	428	519	323	445	339	--	366	315	322
Total	--	--	--	--	1655	2056	1302	1510	1285	--	1197	1185	830
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

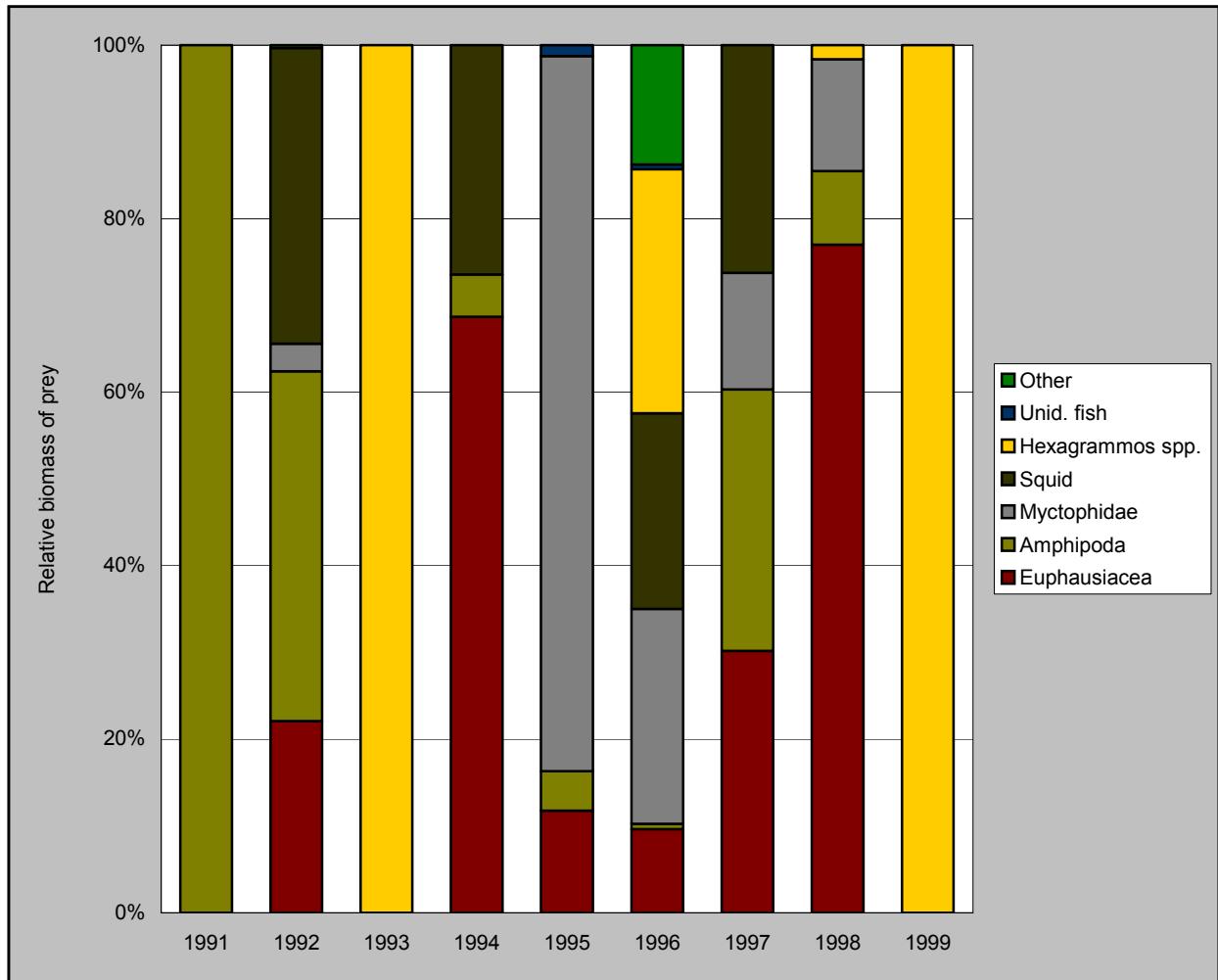


Figure 11. Relative biomass of prey in diets of black-legged kittiwakes at Buldir Island, Alaska.

Table 33. 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									
<i>Neocalanus plumchrus</i>					2.3				
<i>N. cristatus</i>		2.4						8.2	
Amphipoda									
Hyperiidea									
<i>Parathemisto pacifica</i>		23.3		4.9	2.3	0.6	30.2	0.2	
<i>Parathemisto</i> spp.	43.2	13.0							
Gammaridea									
<i>Lysianassidae</i>	56.8	0.3				0.1		0.1	
Unid. Amphipoda		1.3							
Euphausiacea									
<i>Thysanoessa</i> spp.		22.1		68.7	11.8	9.6	30.2		
Unid. Euphausiid							77.0		
Decapoda - shrimp		0.3							
Fish									
Myctophidae									
<i>Stenobrachius leucopsarus</i>						13.4	12.9		
Unid. Myctophidae	3.2				82.4	24.8			
<i>Hexagrammos</i> spp.			100.0			28.1		1.6	100.0
Unid. fish					1.3	0.6			
Offal					13.8				

Table 34. 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					25.0				
<i>Neocalanus plumchrus</i>									
<i>N. cristatus</i>			13.0					18.2	
Unid. Copepoda			4.3						
Amphipoda									
Hyperiidea									
<i>Parathemisto pacifica</i>			13.0		50.0	25.0	14.3	33.3	18.2
<i>Parathemisto</i> spp.	33.3		17.4						
Gammaridea									
<i>Lysianassidae</i>	33.3		4.3				14.3		9.1
Unid. Amphipoda			8.7						
Euphausiacea									
<i>Thysanoessa</i> spp.			47.8		83.3	25.0	14.3	33.3	
Unid. Euphausiid									81.8
Decapoda - shrimp			4.3						
Fish									
Myctophidae									
<i>Stenobrachius leucopsarus</i>							66.7	27.3	
Unid. Myctophidae			43.5			75.0	28.6		
<i>Ammodytes hexapterus</i>	33.3		8.7						
<i>Hexagrammos</i> spp.				71.4			42.9		
Unid. fish	33.3		4.3	28.6		25.0	14.3		
Offal					14.3			9.1	100.0

Table 35. 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

^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 36. Hatching dates of red-legged kittiwake nests by plot at Buldir Island, Alaska, 2003.

Plot	July																													
	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
All	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

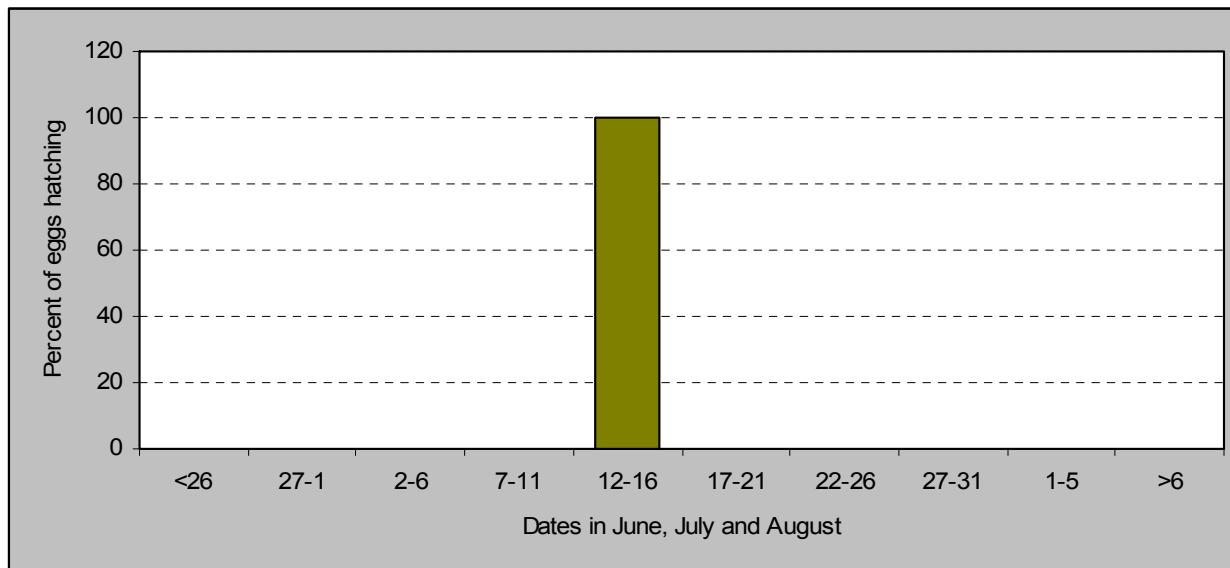


Figure 12. Hatching chronology of red-legged kittiwakes at Buldir Island, Alaska in 2003 (n = 1).

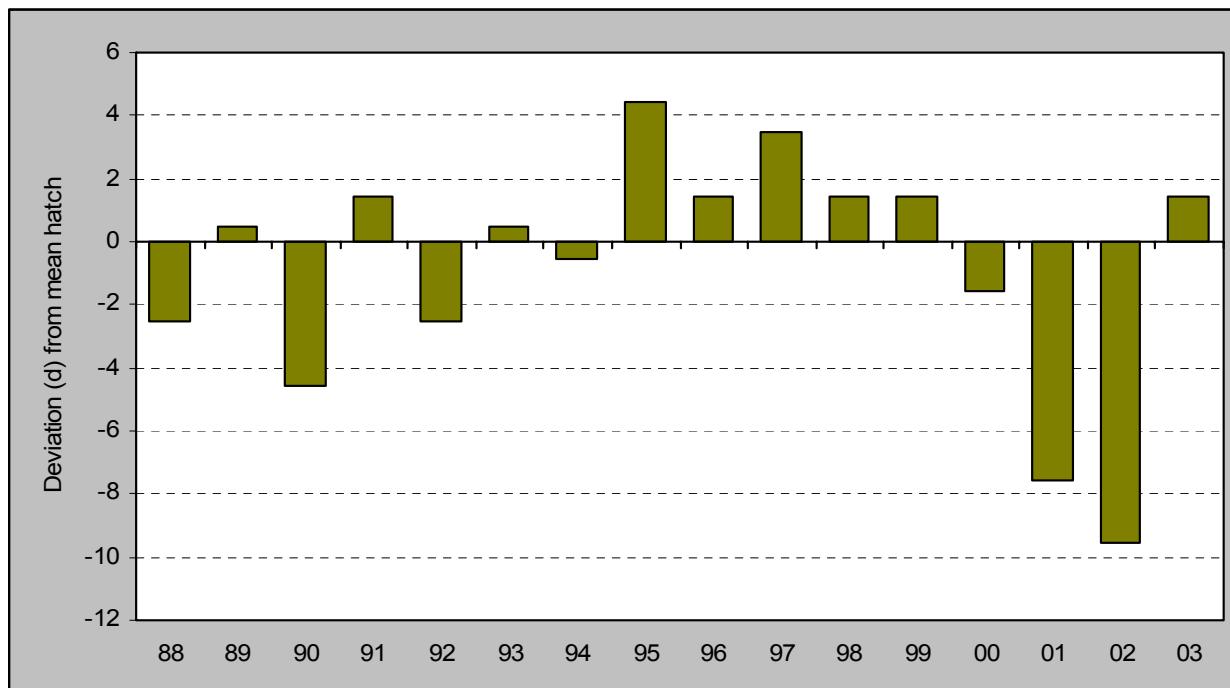


Figure 13. Yearly hatch date deviation (from the 1988-2003 average of 17 July) for red-legged kittiwakes at Buldir Island, Alaska. Numbers below the mean indicate hatch dates earlier, positive numbers indicate hatch dates later.

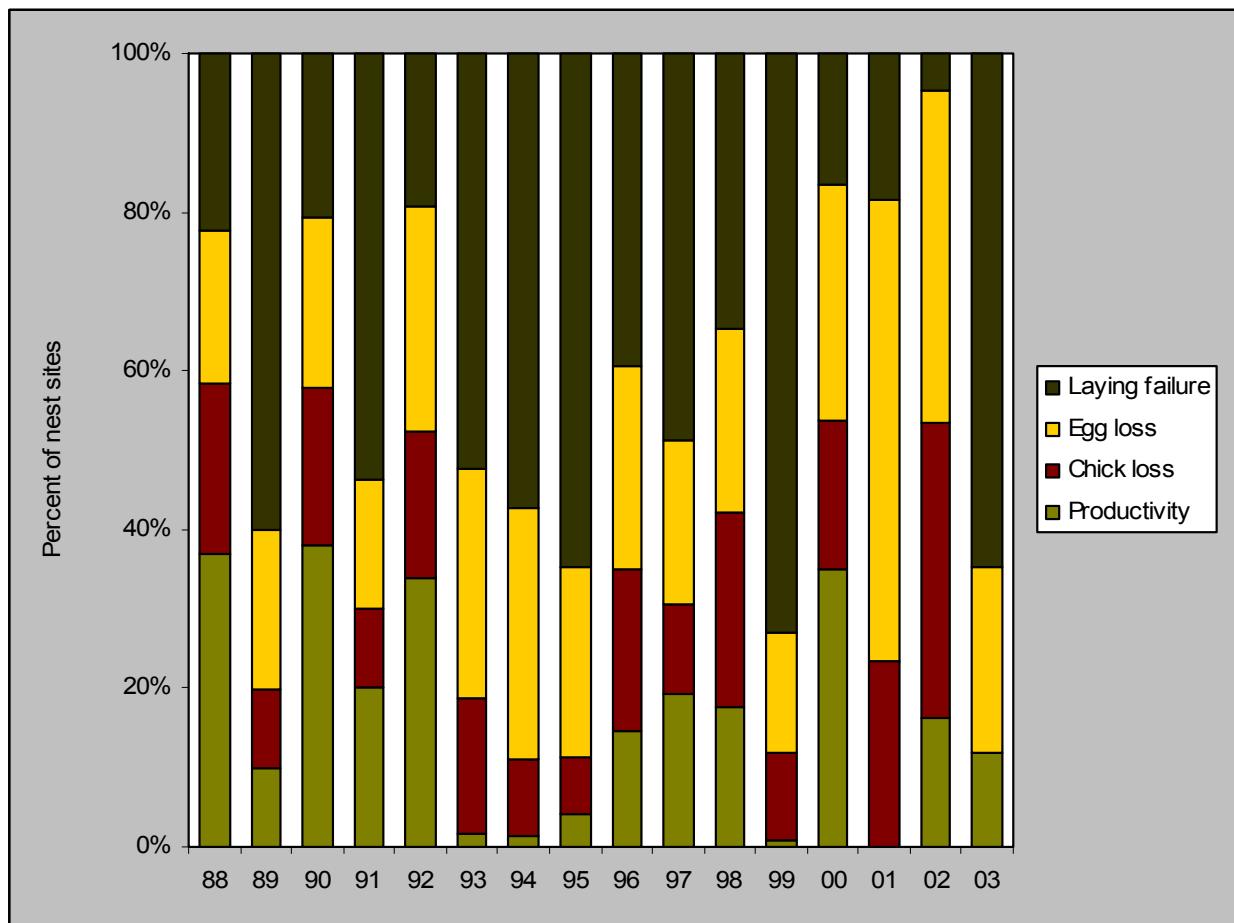


Figure 14. Reproductive performance of red-legged kittiwakes at Buldir Island, Alaska. Laying Failure=(A-B)/A; Egg Loss=(B-C)/A; Chick Loss=(C-D)/A; Productivity=D/A, where A=total number of nests; B=number of nests with ≥ 1 egg; C=number of nests with ≥ 1 chick; D= number of nests with ≥ 1 fledged chick.

Table 37. 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

^aNumber of nests w/ eggs/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.

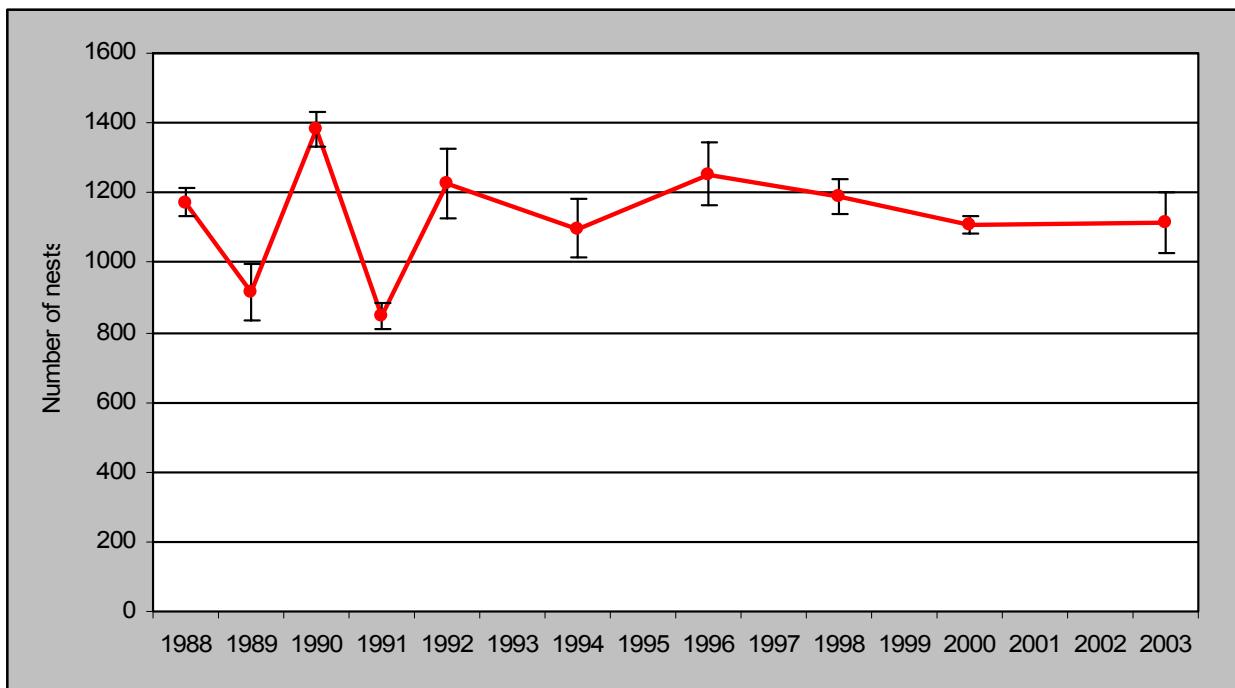


Figure 15. Counts of red-legged kittiwake nests on index plots at Buldir Island, Alaska. Error bars represent the standard deviation of replicate counts in each year.

Table 38 . 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 39 . 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 40. Numbers of red-legged kittiwake nests on index plots at Buldir Island, Alaska in 2003.

Plot (segment)	Count				mean	SD	max.
	1	2	3	4			
The Dip							
1	0	0	0	0	0.0	0.0	0
2	0	0	0	0	0.0	0.0	0
3	1	0	0	0	0.3	0.5	1
4	1	0	1	0	0.5	0.6	1
5	0	0	0	0	0.0	0.0	0
6	29	32	33	32	31.5	1.7	33
7	9	3	2	2	4.0	3.4	9
A	115	115	169	147	136.5	26.4	169
B	19	31	25	25	25.0	4.9	31
C	57	80	107	96	85.0	21.7	107
Total	231	261	337	302	282.8	46.4	337
Kittiwake Lane							
15 (1)	75	67	66	66	68.5	4.4	75
16 (2)	35	29	35	31	32.5	3.0	35
17 (3)	52	56	53	52	53.3	1.9	56
18 (4)	65	84	79	94	80.5	12.1	94
19 (5)	39	54	42	35	42.5	8.2	54
20 (6)	32	35	37	48	38.0	7.0	48
21 (7)	72	59	56	65	63.0	7.1	72
22 (8)	34	54	49	53	47.5	9.3	54
23 (9)	29	28	28	39	31.0	5.4	39
24 (10)	9	16	12	12	12.3	2.9	16
25 (11)	16	25	23	24	22.0	4.1	25
26 (12)	21	28	32	29	27.5	4.7	32
27 (13)	6	12	13	10	10.3	3.1	13
28 (14)	3	7	0	1	2.8	3.1	7
29 (15)	2	3	1	1	1.8	1.0	3
KWLE ^a	227	236	233	243	234.8	6.65	243
KWLW	263	321	293	317	298.5	26.7	321
KWL total	490	557	526	560	533.3	32.7	560
Index plot total ^b	721	818	863	862	816	66.7	863

^a KWLE is Kittiwake Lane East (plots 15-18), KWLW is KWL West (plots 19-28).^b Consists of all plots at The Dip and Kittiwake Lane combined

Table 41. Numbers of red-legged kittiwakes on index plots at Buldir Island, Alaska in 2003.

Plot (segment)	Count				0	SD	max.
	1	2	3	4			
The Dip							
1	0	0	0	0	0.0	0.0	0
2	0	0	0	0	0.0	0.0	0
3	3	0	0	0	0.8	1.5	3
4	1	0	1	0	0.5	0.6	1
5	0	0	0	0	0.0	0.0	0
6	39	49	45	46	44.8	4.2	49
7	12	3	4	3	5.5	4.4	12
A	246	207	231	183	216.8	27.6	246
B	30	40	31	40	35.3	5.5	40
C	126	156	146	117	136.3	17.9	156
Total	457	455	458	389	439.8	33.9	458
Kittiwake Lane							
15(1)	91	87	97	93	92.0	4.2	97
16(2)	52	42	45	54	48.3	5.7	54
17(3)	66	89	72	67	73.5	10.7	89
18(4)	84	125	114	129	113.0	20.3	129
19(5)	65	72	60	59	64.0	5.9	72
20(6)	48	58	56	62	56.0	5.9	62
21(7)	97	109	99	89	98.5	8.2	109
22(8)	50	75	69	63	64.3	10.7	75
23(9)	53	45	49	50	49.3	3.3	53
24(10)	25	27	17	13	20.5	6.6	27
25(11)	36	43	48	42	42.3	4.9	48
26(12)	51	47	49	33	45.0	8.2	51
27(13)	10	18	27	17	18.0	7.0	27
28(14)	3	1	3	6	3.3	2.1	6
29(15)	2	1	1	1	1.3	0.5	2
KWLE ^a	293	343	328	343	326.8	23.6	343
KWLW	440	496	478	435	462.3	29.6	496
KWL total	733	839	806	778	789	44.9	839
Index plot total ^b	1190	1294	1264	1167	1228.8	60.0	1294

^a KWLE is Kittiwake Lane East (plots 15-18), KWLW is KWL West (plots 19-28).^b Consists of all plots at The Dip and Kittiwake Lane combined.

Table 42. 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 43. Red-legged kittiwake nest counts by sub-area at Middle Rock, Buldir Island, Alaska (Middle Rock was not counted in 2003).

Segment (Plot)	1974	1975	1984	1988	1989	1990	1991	1992	1994	1996	1998	2001
I	9	5	0	--	0	0	0	0	0	0	0	0
II	0	0	0	--	0	0	0	0	1	0	0	2
III	0	0	0	--	0	0	0	0	2	0	0	0
IV	0	0	0	--	0	0	0	0	0	0	0	0
V	1	2	1	--	0	0	0	0	0	0	0	1
VI	0	0	0	--	0	0	0	0	0	1	9	0
VII	0	0	0	--	0	2	4	4	0	1	0	2
Total	10	7	1	--	0	2	4	4	3	2	9	5
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

Table 44. Red-legged kittiwake counts by sub-area at Middle Rock, Buldir Island, Alaska (Middle Rock was not counted in 2003).

Segment (Plot)	1974	1975	1984	1988	1989	1990	1991	1992	1994	1996	1998	2001
I	--	--	--	--	0	0	0	0	0	0	0	0
II	--	--	--	--	0	0	0	0	0	0	0	2
III	--	--	--	--	0	0	0	0	0	0	0	0
IV	--	--	--	--	0	0	0	0	0	0	0	0
V	--	--	--	--	3	0	0	0	0	0	5	1
VI	--	--	--	--	0	0	0	0	0	1	13	0
VII	--	--	--	--	4	3	8	4	0	3	0	4
Total	--	--	--	--	7	3	8	4	0	4	18	7
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

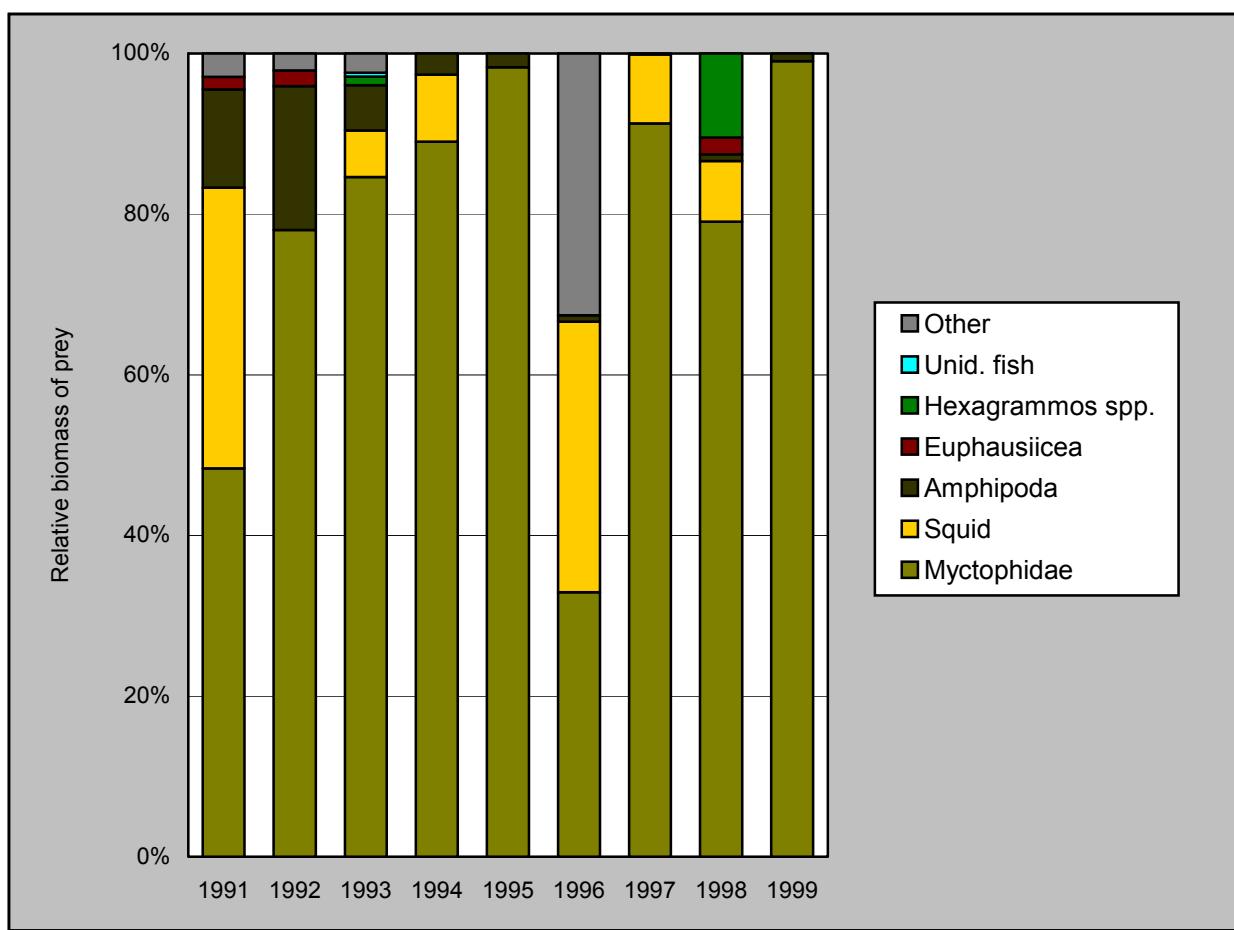


Figure 16. Relative biomass of prey in diets of red-legged kittiwakes at Buldir Island, Alaska.

Table 45. 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									
<i>Parathemisto pacifica</i>					0.2				
<i>Parathemisto</i> 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									
<i>Thysanoessa</i> spp.	1.5	2.0							2.1
Unid Euphausiid									
Decapoda - shrimp	2.9	2.1	1.1						
Fish									
Osmeridae			1.3						
Myctophidae									
<i>Stenobrachius leucopsarus</i>			84.6				91.3	69.0	
Unid. Myctophidae	48.3	78.0		89.0	98.3	32.9		10.0	99.1
<i>Hexagrammos</i> spp.			1.1					10.5	
Unid. fish			0.5						
Offal						32.6			

Table 46. 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									
<i>Parathemisto pacifica</i>					7.4				
<i>Parathemisto</i> spp.		15.4		7.7					
Gammaridea									
<i>Lysianassidae</i>	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									
<i>Thysanoessa</i> spp.	16.7	7.7							11.1
Unid Euphausiid									
Decapoda - shrimp	33.3	7.7	10.3						
Fish									
Osmeridae			2.6						
Myctophidae									
<i>Stenobrachius leucopsarus</i>			82.1				87.5	88.9	
Myctophidae - not <i>S. leuco.</i>			2.6					22.2	
Unid. Myctophidae	55.6	84.6		100.0	100.0	33.3			100.0
<i>Ammodytes hexapterus</i>	5.6								
<i>Hexagrammos</i> spp.			2.6					44.4	
Unid. fish	16.7	3.8	10.3		7.7				
Offal						33.3			

Table 47. 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

^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 48. Hatching dates of thick-billed murre eggs by plot at Buldir Island, Alaska, 2003^a.

Plot	July																																
	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
38a															3																		1
38b										1				6																			2
38c											1				3																		1
38d																					4											2	
38e											1				7					4												2	
39a														1					3														1
39b														2				8															1
39c														1				2															1
40a														2				7															1
43												1			3				9													1	
45a														1				5															1
45b																		3															1
46a											1			1																		3	

Table 48 (continued).

Plot	Aug																																	
	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			
38a																																		
38b														1				1																
38c														1																				
38d																																		
38e																																		
39a																	1																	
39b																																		
39c																																		
40a																	1																	
43																																		
45a																																		
45b																																		
46a																	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.

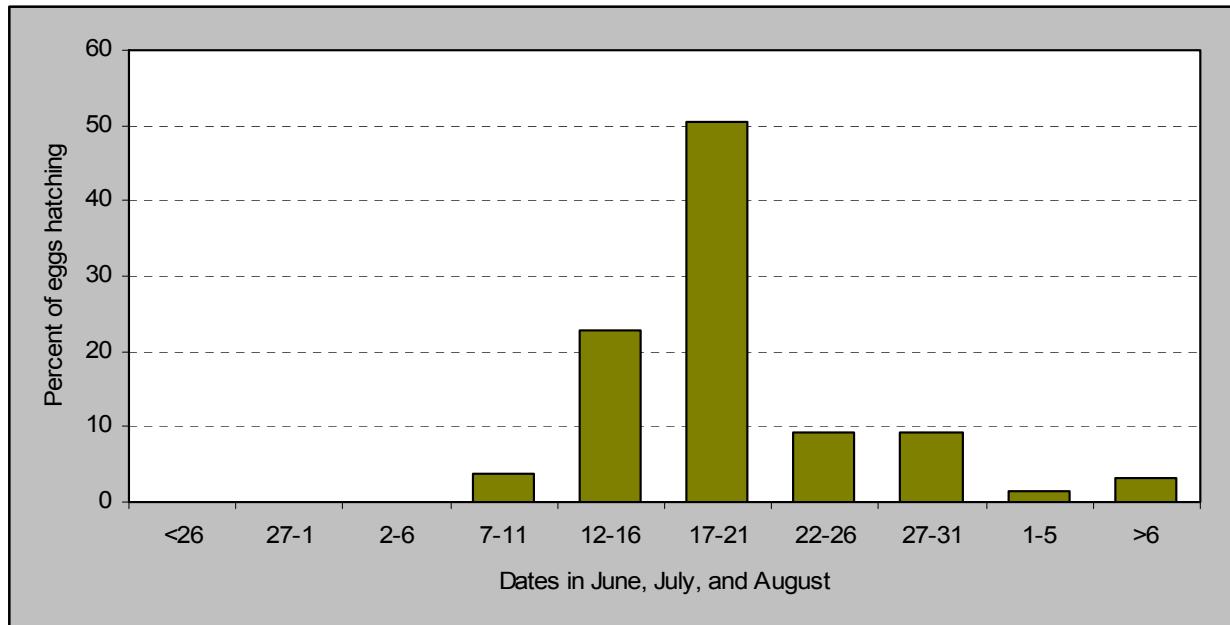


Figure 17. Hatching chronology of thick-billed murres at Buldir Island, Alaska in 2003.

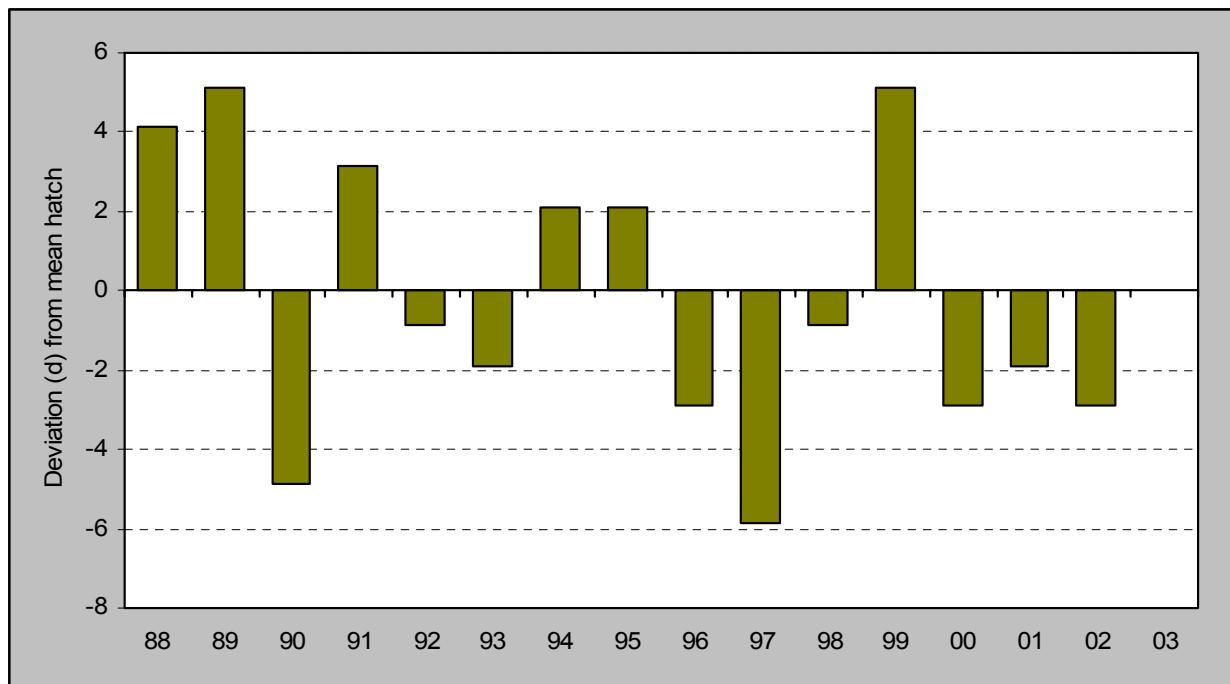


Figure 18. Yearly hatch date deviation (from the 1988-2003 average of 17 July) for thick-billed murres at Buldir Island, Alaska. Numbers below the mean indicate hatch dates earlier, positive numbers indicate hatch dates later.

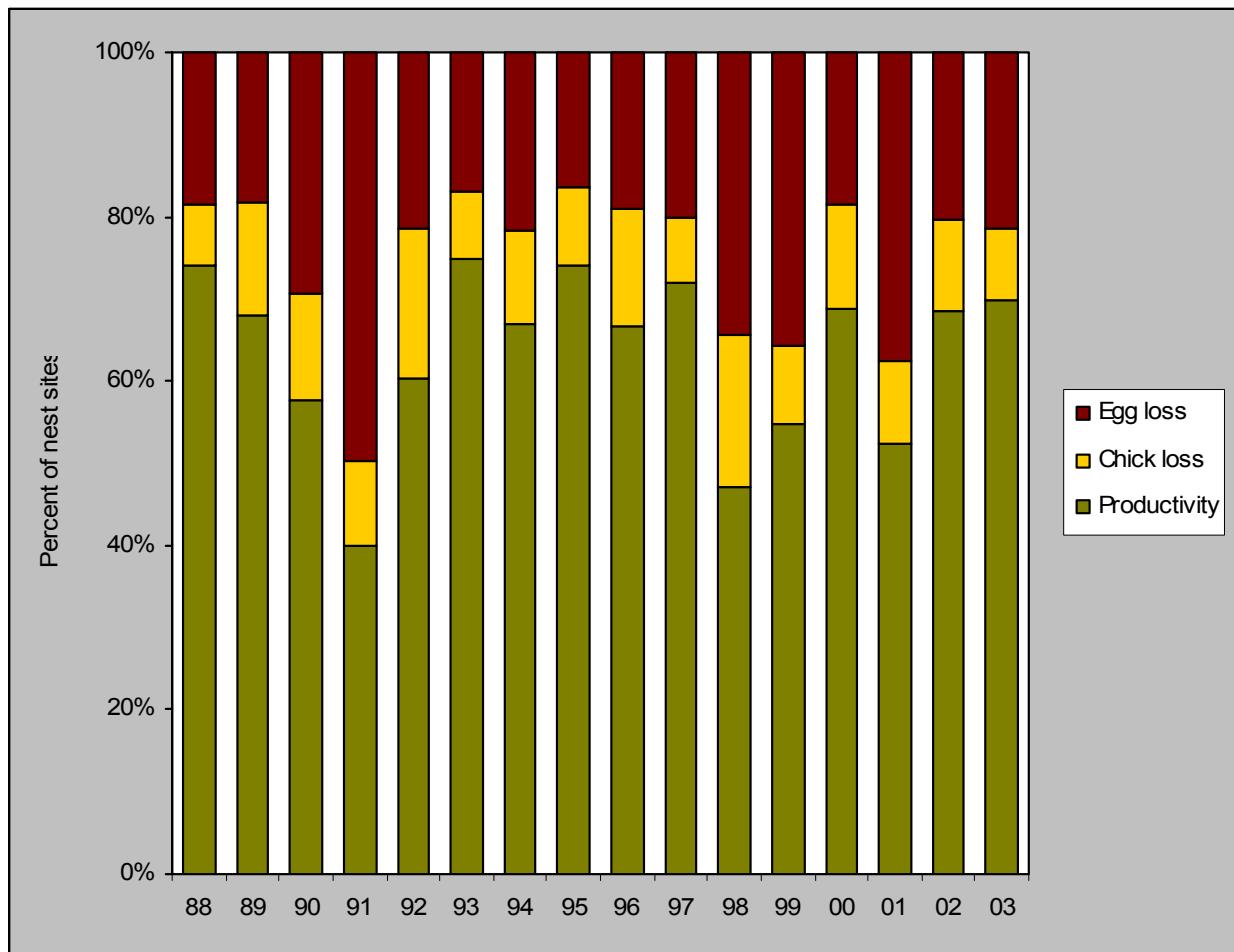


Figure 19. Reproductive performance of thick-billed murres at Buldir Island, Alaska. Egg Loss=(A-B)/A; Chick Loss=(B-C)/A; Productivity=C/A, where A=number nest sites, B=number of nest sites with a chick; C=number of nests sites with fledged chick.

Table 49. 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

^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 50. Reproductive performance of thick-billed murres on index plots at Buldir Island, Alaska, in 2003.

Parameter	Plot													Statistics			
	38a	38b	38c	38d	38e	39a	39b	39c	40a	43	45a	45b	46a	Total	n	mean	SD
no. of sites with an egg (A)	26	68	20	19	38	9	26	10	20	25	17	14	24	316			
no. of sites with chick (B)	16	53	19	15	31	7	22	6	19	16	14	10	20	248			
no. of sites where chick fledged (C)	13	47	14	14	28	7	22	4	17	13	14	9	19	221			
hatching success (B/A)	0.62	0.78	0.95	0.79	0.82	0.78	0.85	0.60	0.95	0.64	0.82	0.71	0.83		13	0.78	0.03
fledging success (C/B)	0.81	0.89	0.74	0.93	0.90	1.00	1.00	0.67	0.89	0.81	1.00	0.90	0.95		13	0.89	0.02
reproductive success (C/A)	0.50	0.69	0.70	0.74	0.74	0.78	0.85	0.40	0.85	0.52	0.82	0.64	0.79		13	0.70	0.03

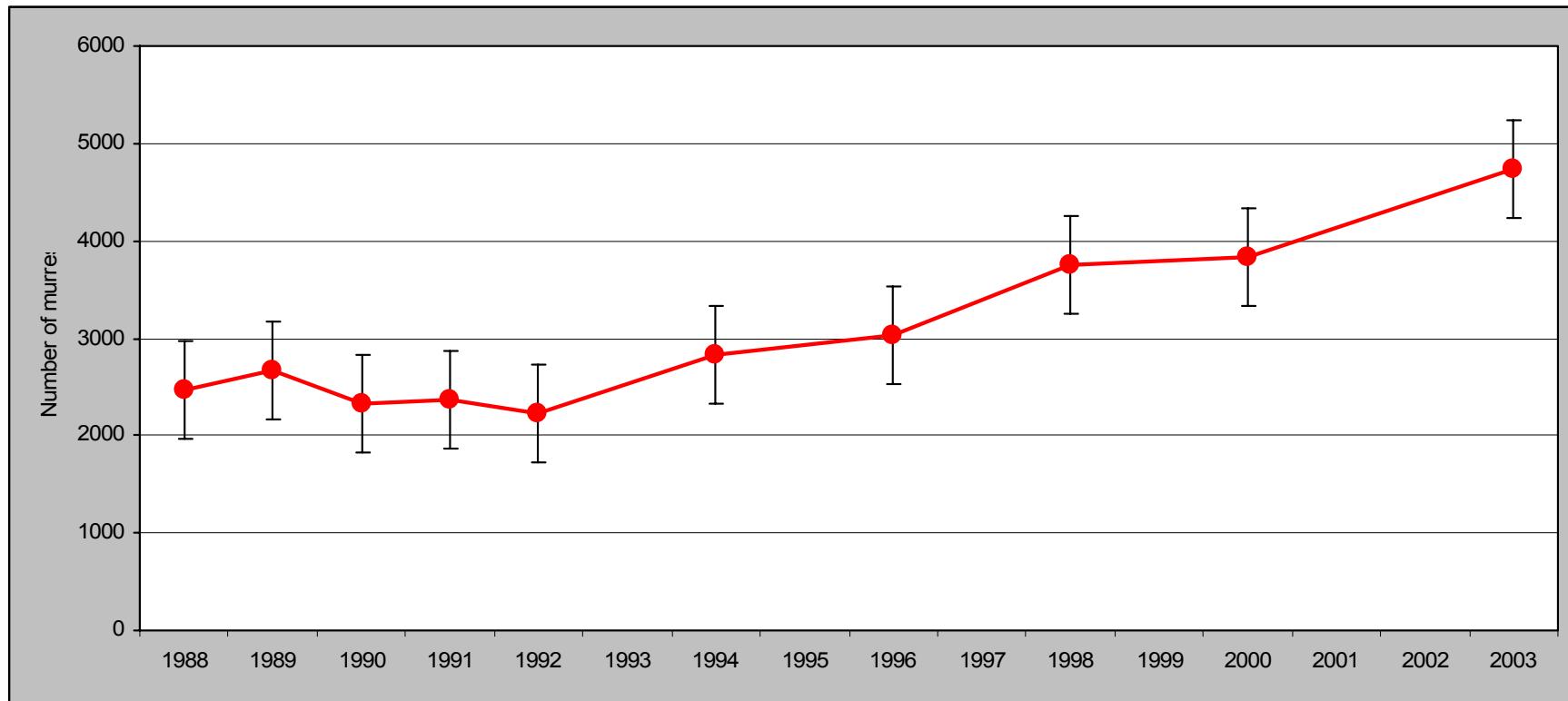


Figure 20. Counts of thick-billed murres on index plots at Buldir Island, Alaska. Error bars represent the standard deviation of replicate counts in each year.

Table 51. 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 52. Thick-billed murre population counts on index plots at Buldir Island, Alaska in 2003.

Plot (segment)	Count				Statistics		
	1	2	3	4	0	S.D.	max
The Dip							
1	0	0	0	0	0	0.0	0
2	35	42	35	42	38.5	4.0	42
3	167	174	199	212	188.0	21.1	212
4	85	86	51	68	72.5	16.5	86
5	45	55	66	62	57.0	9.2	66
6	68	73	76	83	75.0	6.3	83
7	57	133	97	104	97.8	31.3	133
A	320	323	322	352	329.3	15.2	352
B	476	600	475	632	545.8	82.2	632
C	335	674	650	705	591.0	172.1	705
8	104	179	228	239	187.5	61.5	239
9	16	8	8	8	10.0	4.0	16
10	0	14	4	2	5.0	6.2	14
11	60	64	70	79	68.3	8.3	79
12	475	487	586	608	539.0	67.7	608
13	94	86	118	126	106.0	19.0	126
14	36	44	46	53	44.8	7.0	53
Total	2373	3042	3031	3375	2955.3	419.7	3375
Kittiwake Lane							
15 (1)	151	142	151	138	145.5	6.6	151
16 (2)	372	374	329	296	342.8	37.4	374
17 (3)	299	238	173	380	272.5	88.2	380
18 (4)	69	104	120	163	114.0	39.0	163
19 (5)	152	82	71	170	118.8	49.5	170
20 (6)	117	75	45	158	98.8	49.3	158
21 (7)	47	12	0	5	16.0	21.2	47
22 (8)	10	10	16	7	10.8	3.8	16
23 (9)	0	0	0	0	0.0	0.0	0
24 (10)	0	0	0	0	0.0	0.0	0
25 (11)	0	0	0	0	0.0	0.0	0
26 (12)	0	0	0	0	0.0	0.0	0
27 (13)	0	0	0	0	0.0	0.0	0
28 (14)	196	128	187	248	189.8	49.2	248
29 (15)	27	15	20	22	21.0	5.0	27
KWL East ^a	891	858	773	977	874.8	84.4	977
KWL West	549	322	339	610	455.0	146.1	610
KWL total	1440	1180	1112	1587	1329.8	222.2	1587
Index plot ^b	3813	4222	4143	4962	4285.0	484.9	4962
Total							

^a KWLE is Kittiwake Lane East (plots 15-18), KWLW is KWL West (plots 19-29).

^b Consists of all plots at The Dip and Kittiwake Lane combined.

^c Plots 19-28.

^d Consists of all plots at The Dip and Kittiwake Lane combined.

Table 53. 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 54. Thick-billed murre counts by sub-area at Middle Rock, Buldir Island, Alaska (Middle Rock was not counted in 2003).

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

^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 55. Breeding chronology dates for common murres at Buldir Island, Alaska.

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

Table 56. Reproductive performance of common murres at Buldir Island, Alaska.

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

Table 57. 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 58. 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	1 Jul	--	--	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

^aHatch 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; ≤ 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).

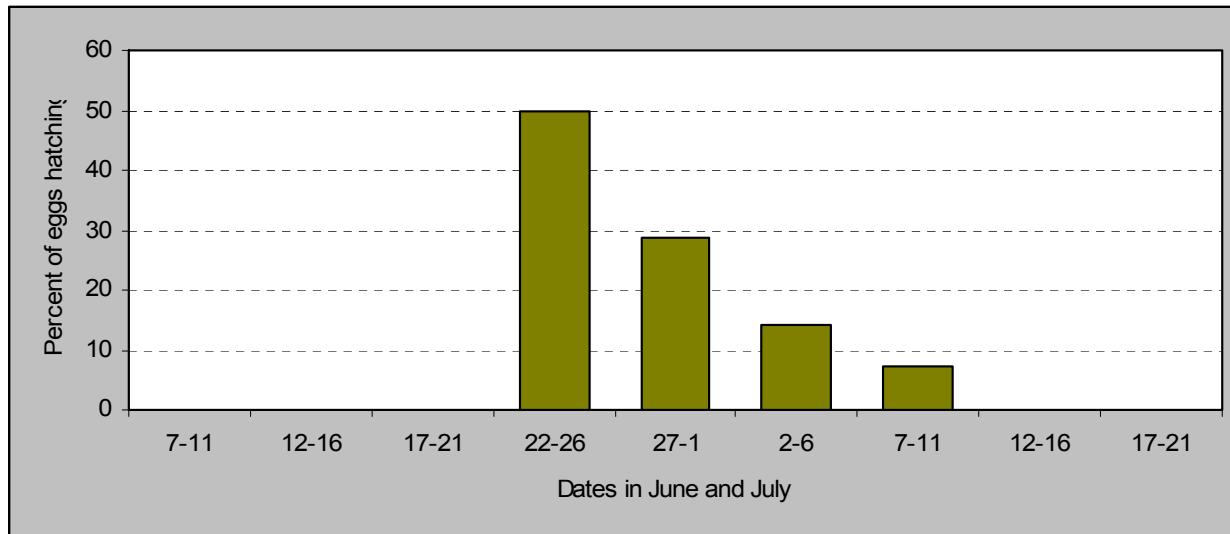


Figure 21. Hatching chronology of least auklets at Buldir Island, Alaska in 2003.

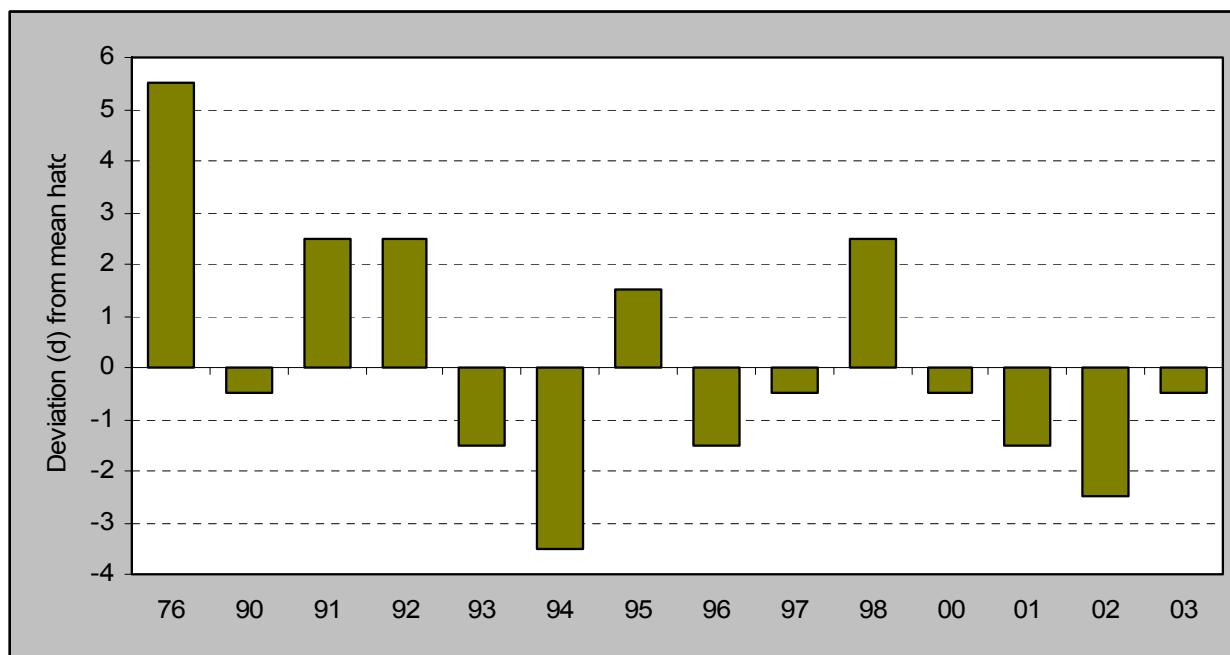


Figure 22. Yearly hatch date deviation (from the 1988-2003 average of 17 July) for least auklets at Buldir Island, Alaska. Numbers below the mean indicate hatch dates earlier, positive numbers indicate hatch dates later.

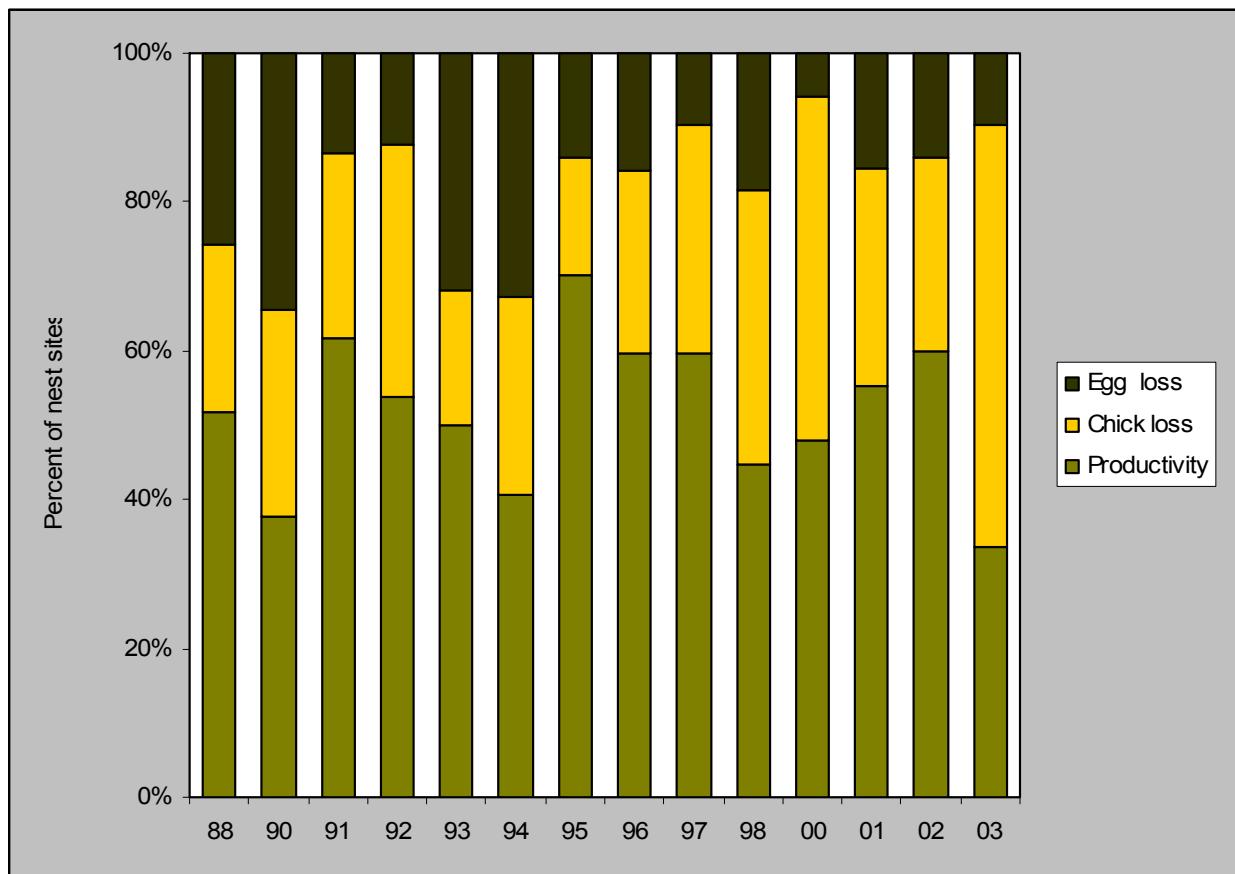


Figure 23. Reproductive performance of least auklets at Buldir Island, Alaska. Egg loss=(A-B)/A; Chick loss=(B-C)/A; Productivity=C/A, where A=number of nest sites, B=number of nest sites with a chick, C=number of sites with fledged chick.

Table 59. 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
No. eggs found (A)	28	31	60	61	81	89	44	64	64	57	84	76	0	69	65	50	83
No. eggs lost to:																	
disappearance	--	6	18	18	9	9	9	14	3	6	7	8	--	4	5	4	2
abandonment	--	0	2	2	0	1	3	6	3	1	0	6	--	0	5	3	4
breakage	--	2	3	1	2	1	2	1	3	2	1	0	--	0	0	0	2
No. eggs hatched (B)	19	23	37	40	70	78	30	43	55	48	76	62	--	65	55	43	75
No. chicks lost to:																	
disappearance	--	5	--	16	14	26	4	10	9	7	22	24	--	26	15	10	39
death	--	2	--	1	6	4	4	7	1	7	3	4	--	6	4	3	8
No. chicks fledged (C)	--	16	--	23	50	48	22	26	45	34	50	34	--	33	36	30	28
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
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
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
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

^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.

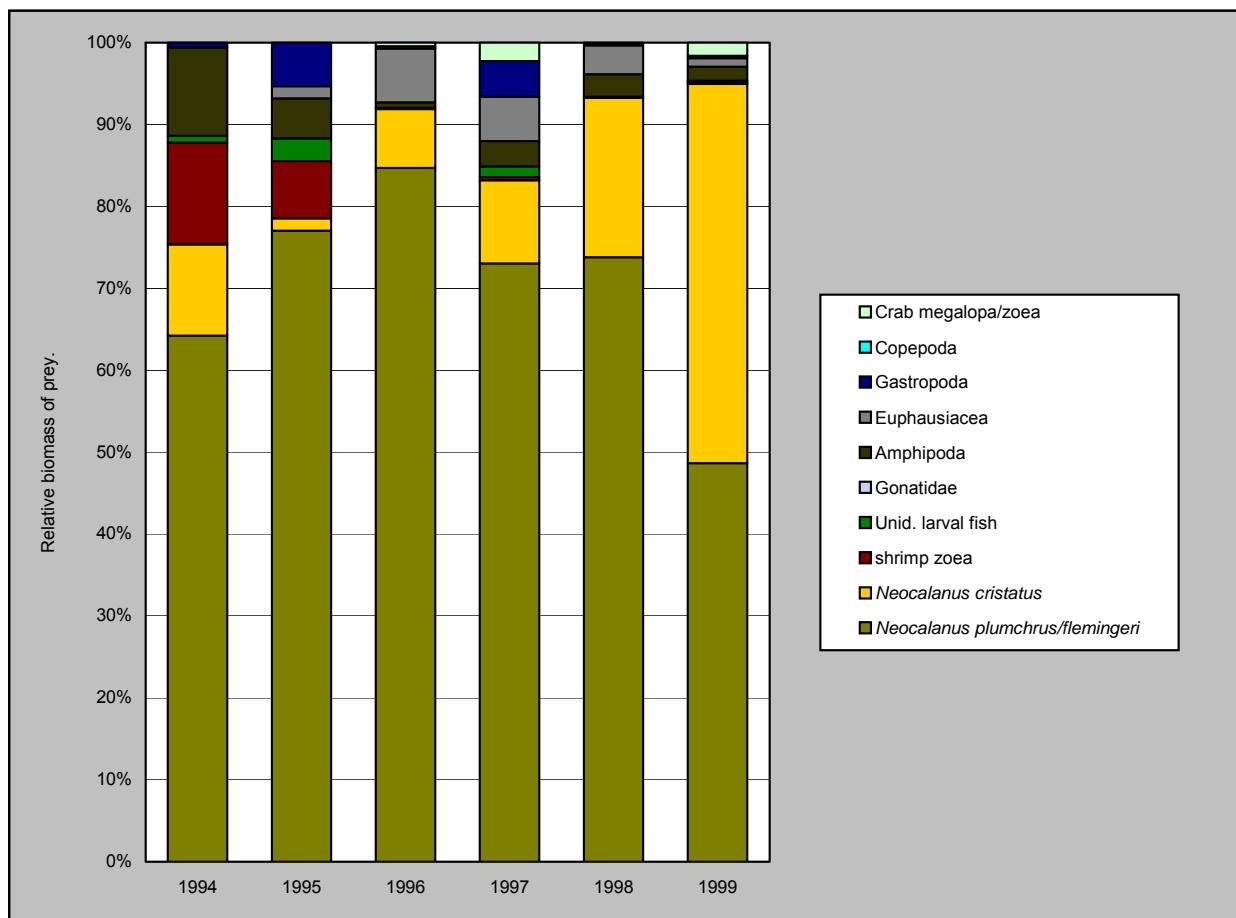


Figure 24. Relative biomass of prey in diets of least auklets at Buldir Island, Alaska.

Table 60. 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					
<i>Limacina helicina</i>					0.2	
Pteropoda		5.3	0.3	4.4		0.3
Copepoda						
<i>Neocalanus plumchrus/flemingeri</i>	64.2	77.1	84.5	73.0	73.9	48.7
<i>N. cristatus</i>	11.1	1.5	7.2	10.2	19.5	46.3
<i>Calanus marshallae</i>					<0.1	
<i>Pachyptilus pacificus</i>						<0.1
<i>Pareuchaeta birostrata</i>						<0.1
Amphipoda						
Hyperiidea						
<i>Hyperoche medusarum</i>		3.6	0.1			
<i>Parathemisto pacifica</i>	7.5	1.3	0.6	1.2	<0.1	0.6
<i>Primno macropa</i>	3.3			1.8		1.1
Gammaridea						
<i>Erichtonius</i> spp.					2.7	
Euphausiacea						
<i>Thysanoessa</i> 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 61. 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					
<i>Limacina helicina</i>					34.6	
Pteropoda		75.0	18.8	54.8		40.6
Copepoda						
<i>Neocalanus plumchrus/flemingeri</i>	100.0	100.0	100.0	100.0	100.0	93.8
<i>N. cristatus</i>	75.0	37.5	12.5	58.1	69.2	81.3
<i>Calanus marshallae</i>					7.7	
<i>Pachyptilus pacificus</i>						3.1
<i>Pareuchaeta birostrata</i>						3.1
Amphipoda						
Hyperiidea						
<i>Hyperoche medusarum</i>		50.0	12.5			
<i>Parathemisto pacifica</i>	75.0	50.0	31.3	19.4	11.5	31.3
<i>Primno macropa</i>	25.0			25.8		18.8
Gammaridea						
<i>Erichitonius</i> spp.					34.6	
Euphausiacea						
<i>Thysanoessa</i> 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 62. 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

^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).

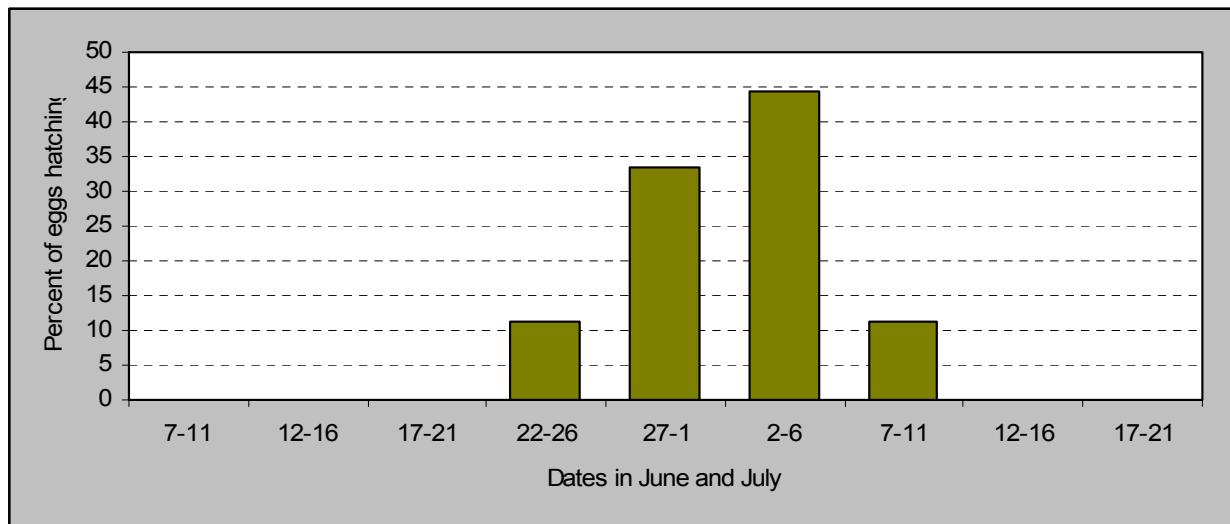


Figure 25. Hatching chronology of crested auklets at Buldir Island, Alaska in 2003.

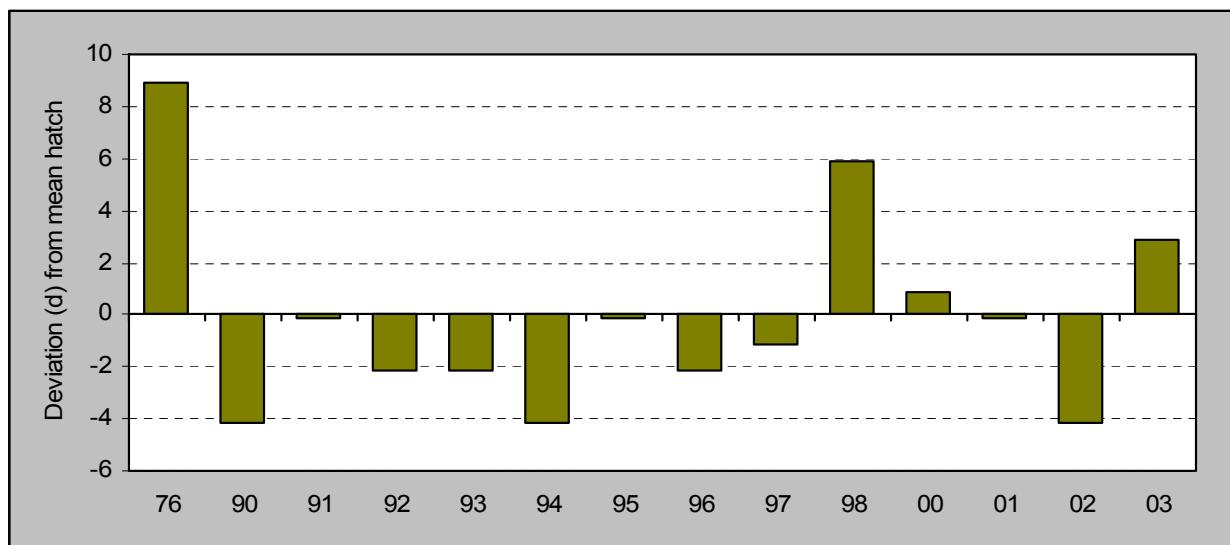


Figure 26. Yearly hatch date deviation (from the 1988-2003 average of 17 July) of crested auklets at Buldir Island, Alaska. Numbers below the mean indicate hatch dates earlier; positive numbers indicate hatch dates later.

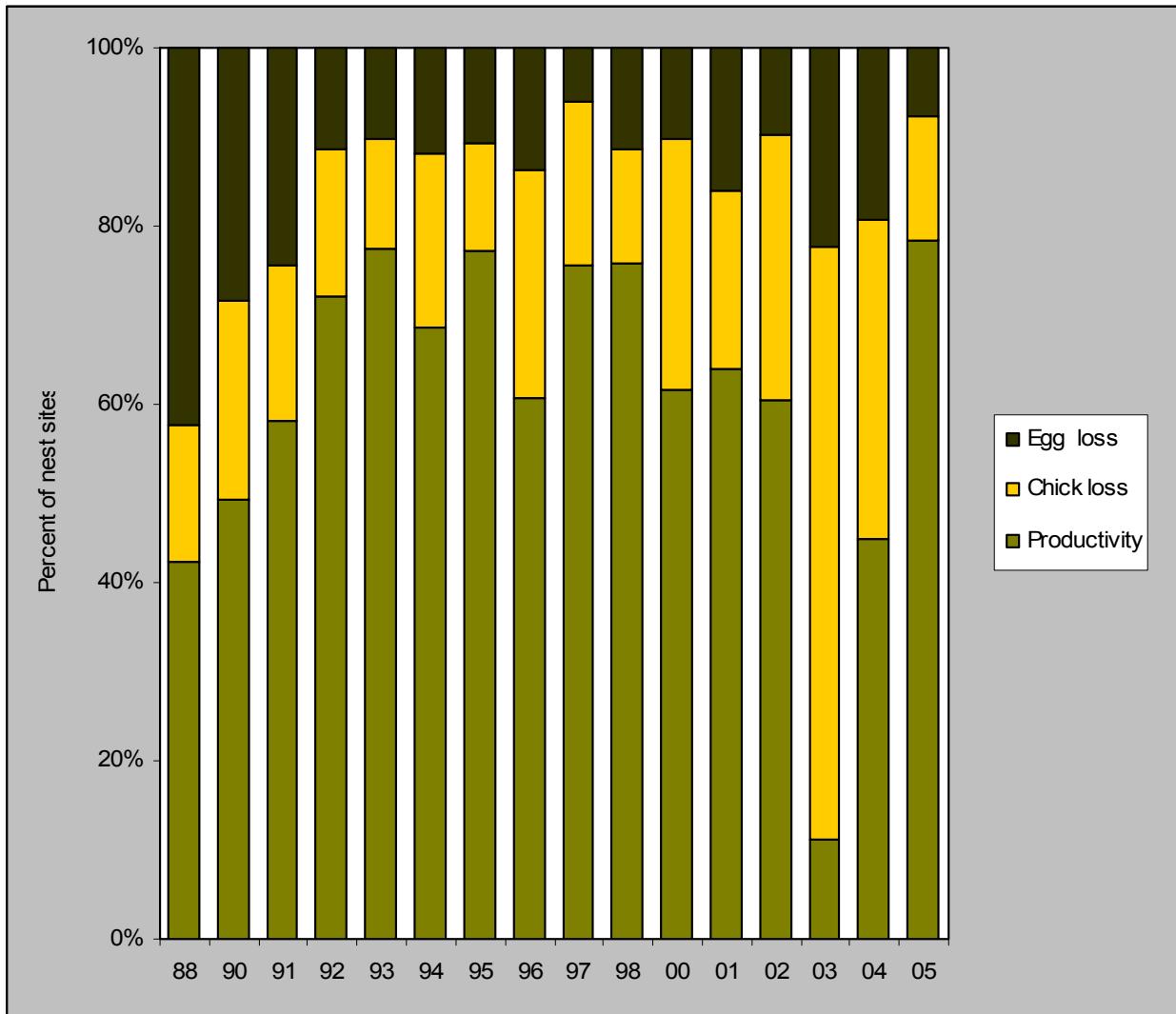


Figure 27. Reproductive performance of crested auklets at Buldir Island, Alaska. Egg loss=(A-B)/A; Chick loss=(B-C)/A; Productivity=C/A, where A=number of nest sites, B=number of nest sites with a chick, C=number of sites with fledged chick.

Table 63. 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
No. eggs found (A)	59	33	83	67	74	79	49	67	66	66	82	70	0	78	75	81	45
No. eggs lost to:																	
disappearance	--	4	23	15	13	7	3	4	5	7	2	4	--	6	6	3	4
abandonment	--	9	4	3	3	2	2	2	1	2	2	4	--	1	6	5	6
breakage	--	1	3	1	2	0	0	2	1	0	1	0	--	1	0	0	0
No. eggs hatched (B)	45	19	53	48	56	70	44	59	59	57	77	62	--	70	63	73	35
No. chicks lost to:																	
disappearance	--	1	--	13	12	12	6	9	7	9	14	9	--	17	8	16	14
death	--	4	--	2	1	1	0	4	1	8	1	0	--	5	7	8	16
No. chicks fledged (C)	--	14	--	33	43	57	38	46	51	40	62	53	--	48	48	49	5
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
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
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
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

^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 26 days before disappearing or 22 days at time of last visit if chicks were still present.

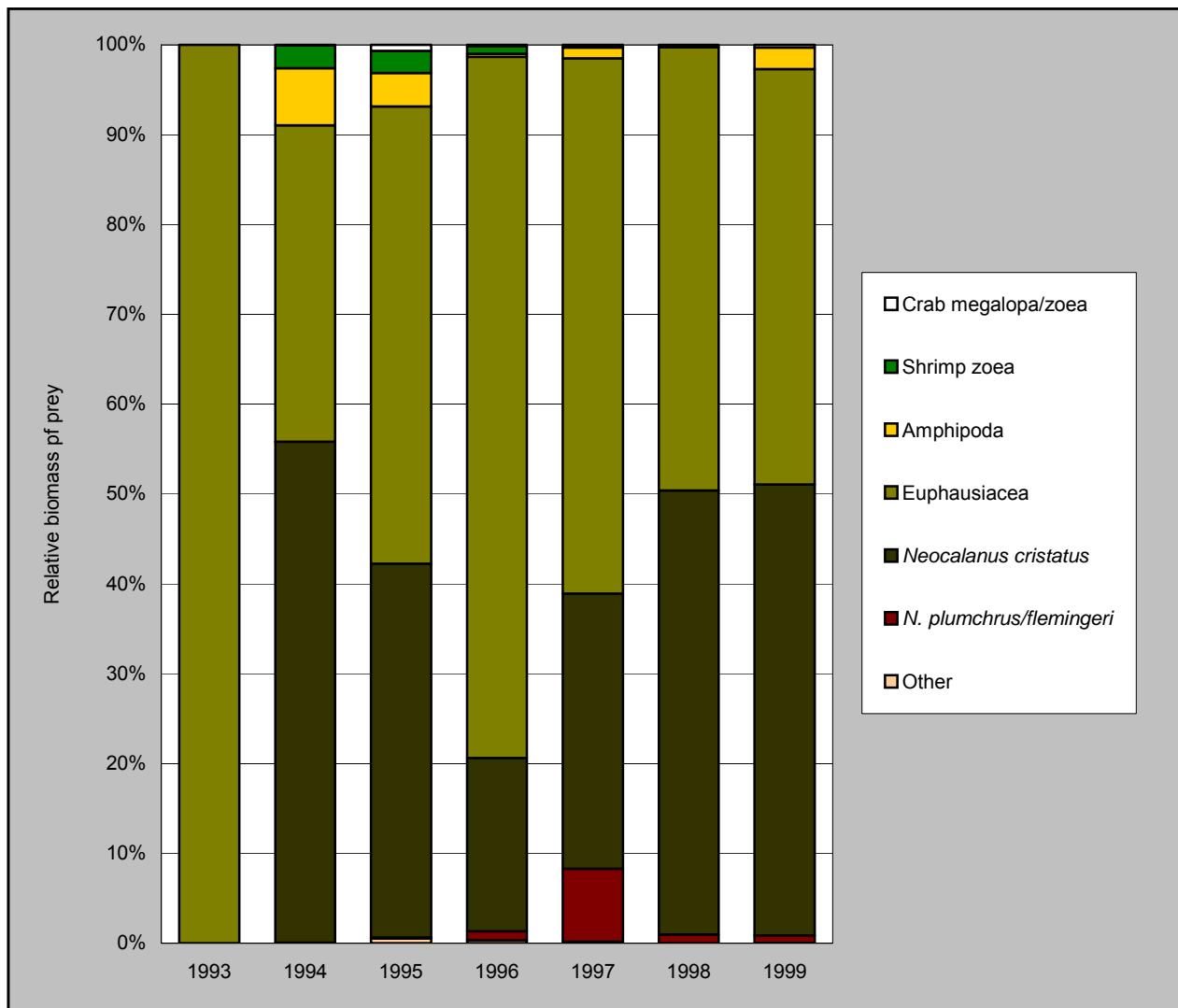


Figure 28. Relative biomass of prey in diets of crested auklets at Buldir Island, Alaska.

Table 64. 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							
<i>Neocalanus plumchrus/flemingeri</i>	0.1	0.1	1.0	8.1	1.0	7.5	
<i>N. cristatus</i>	55.8	41.6	19.3	30.7	49.5	50.2	
Amphipoda							
Hyperiidea							
<i>Hyperoche medusarum</i>				<0.1			
<i>Parathemisto pacifica</i>	5.6	3.7	0.3	1.2	0.3	2.3	
<i>Primno macropa</i>	0.7					0.1	
Euphausiacea							
<i>Thysanoessa</i> spp.	100.0	35.2	50.9	78.1	59.6	49.3	46.2
Unid. Euphausiid							<0.1
Euphausiid furcilla							
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 65. 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							
<i>Neocalanus plumchrus/flemingeri</i>		16.2	6.4	17.9	39.6	45.6	15.9
<i>N. cristatus</i>		91.9	78.7	34.6	63.0	94.2	92.0
Amphipoda							
Hyperiidea							
<i>Hyperoche medusarum</i>				2.6			
<i>Parathemisto pacifica</i>		43.2	51.1	32.1	50.3	36.9	37.5
<i>Primno macropa</i>		21.6					1.1
Euphausiacea							
<i>Thysanoessa</i> 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							
(Nematodes - probably not prey)		8.5	3.8	4.2		3.9	2.3
					28.3		

Table 66. 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	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

^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, but less than 10 days apart or estimated event dates (e.g. "bird Incubating" on first visit followed by "chick" on the next visit).

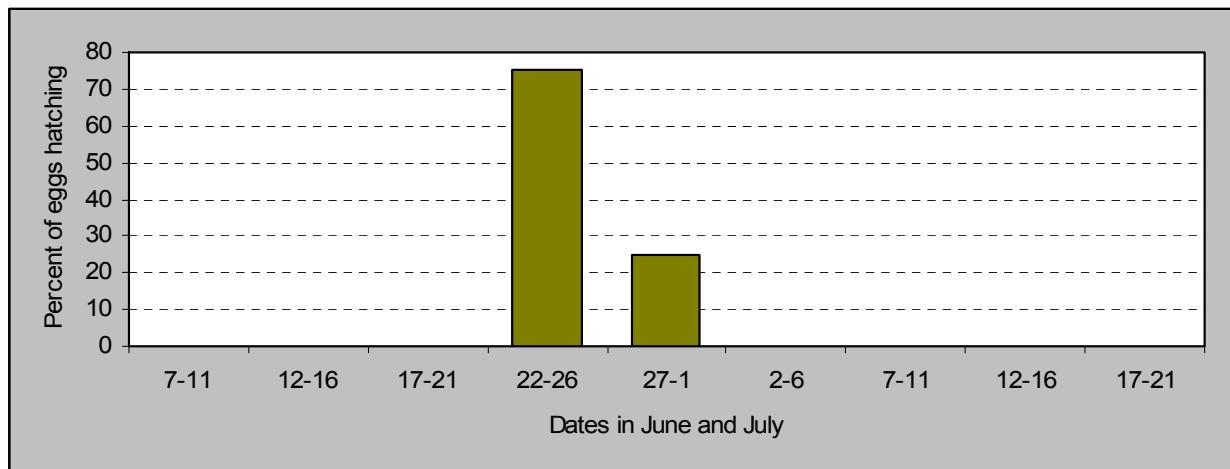


Figure 29. Hatching chronology of whiskered auklets at Buldir Island, Alaska in 2003.

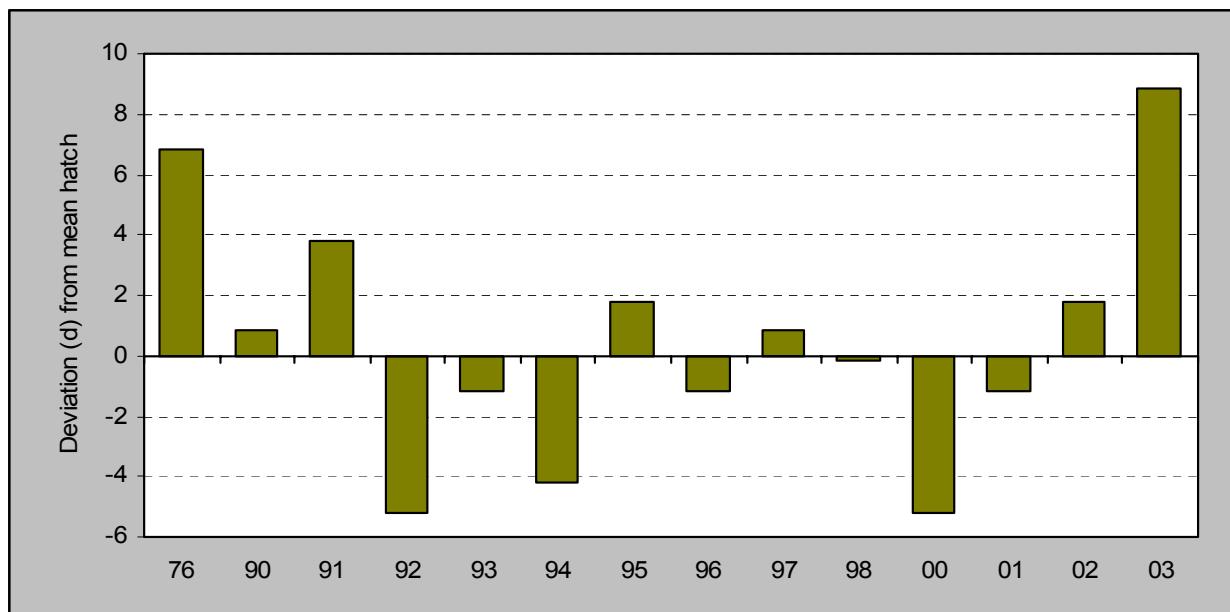


Figure 30. Yearly hatch date deviation (from the 1988-2003 average of 17 July) of whiskered auklets at Buldir Island, Alaska. Numbers below the mean indicate hatch dates earlier; positive numbers indicate hatch dates later.

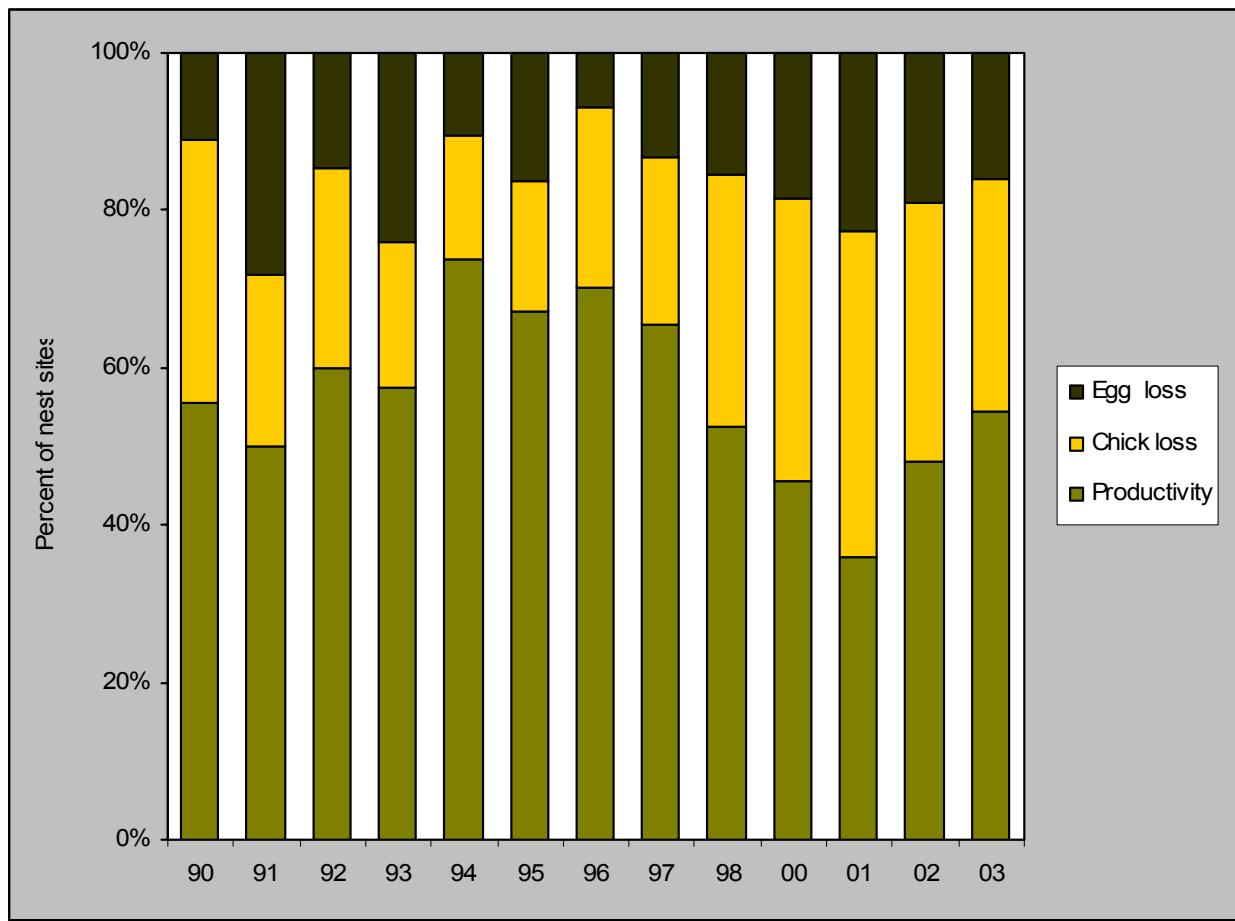


Figure 31. Reproductive performance of whiskered auklets at Buldir Island, Alaska. Egg loss=(A-B)/A; Chick loss=(B-C)/A; Productivity=C/A, where A=number of nest sites, B=number of nest sites with a chick, C=number of sites with fledged chick.

Table 67. Reproductive performance of whiskered auklets at Buldir Island, Alaska.

Parameter ^a	1976	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
No. eggs found (A)	7	7	16	9	46	55	54	57	67	57	90	78	0	70	75	100	44
No. eggs lost to:																	
disappearance	--	0	1	1	5	5	8	4	2	1	8	9	--	4	5	6	3
abandonment	--	0	2	0	4	3	4 ^b	2	9	3	3	2	--	9	12	10	4
breakage	--	0	2	0	4	0	1	0	0	0	1	1	--	0	0	3	0
No. eggs hatched (B)	6	7	11	8	33	47	41	51	56	53	78	66	--	57	58	81	37
No. chicks lost to:																	
disappearance	--	--	--	2	7	9	6	6	10	6	17	20	--	20	5	21	9
death	--	--	--	1	3	5	4	3	1	7	2	5	--	5	26	12	4
No. chicks fledged (C)	--	--	--	5	23	33	31	42	45	40	59	41	--	32	27	48	24
Hatching success (B/A)	0.86	1.00	0.69	0.89	0.72	0.85	0.76	0.89	0.84	0.93	0.87	0.85	--	0.81	0.77	0.81	0.84
Fledging success (C/B) ^b	--	--	--	0.63	0.70	0.70	0.76	0.82	0.80	0.75	0.76	0.62	--	0.56	0.47	0.59	0.65
Reproductive success (C/A)	--	--	--	0.56	0.50	0.60	0.57	0.74	0.67	0.70	0.66	0.53	--	0.46	0.36	0.48	0.55
Productivity (hs x fs)	--	--	--	0.56	0.50	0.60	0.58	0.73	0.67	0.70	0.66	0.53	--	0.46	0.36	0.48	0.55

^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 32 days before disappearing or 29 days at time of last visit, if chicks were still present.

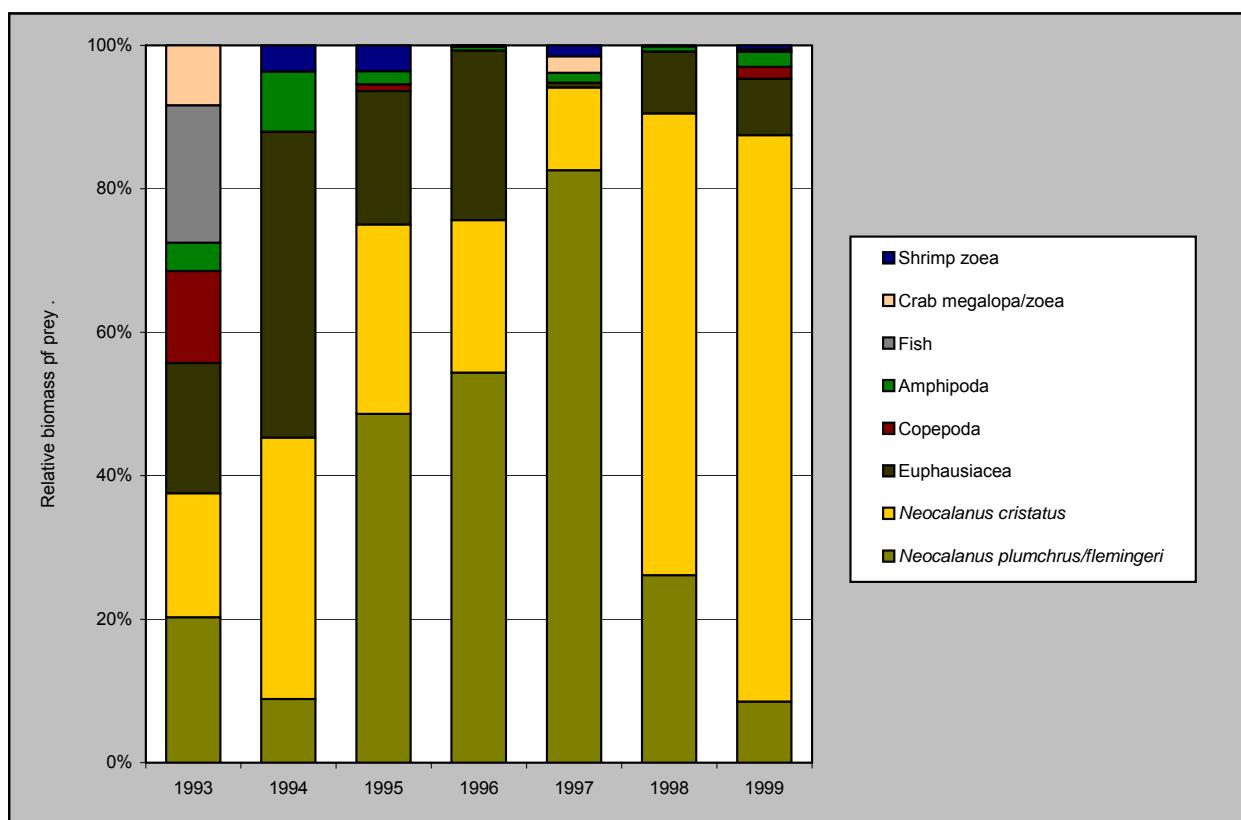


Figure 32. Relative biomass of prey in diets of whiskered auklets at Buldir Island, Alaska.

Table 68. 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. <i>Limacina helicina</i>)	1.5		0.7	0.3	2.1	0.2	0.2
Copepoda							
<i>Neocalanus plumchrus/flemingeri</i>	21.8	8.9	48.3	54.2	80.9	26.1	8.5
<i>N. cristatus</i>	18.6	36.4	26.2	21.2	11.3	64.3	78.8
<i>Calanus pacifica</i>			0.1				
<i>Pachyptilus pacificus</i>							1.0
<i>Pareuchta birostrata</i>							0.7
<i>Lophotrix frontalis</i>							<0.1
Unid. Copepoda	13.8		0.9				
Amphipoda							
Hyperiidea							
<i>Hyperoche medusarum</i>			1.7	0.5			
<i>Parathemisto pacifica</i>	3.9	0.5	0.1	<0.1	<0.1		
<i>Primno macropa</i>	0.3	7.9			1.3	0.7	2.1
Gammaridea							
Talitridae				0.1			
Euphausiacea							
<i>Thysanoessa</i> 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 - <i>Hexagrammos</i> spp.	20.6						0.2

Table 69. 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.

	1993	1994	1995	1996	1997	1998	1999
No. samples	24	16	48	71	36	26	43
Scyphozoa				1.4			
Gastropoda							
Unid. snail		25.0					
Pteropoda – (prob. <i>Limacina helicina</i>)	4.2		39.6	50.7	66.7	34.6	44.2
Copepoda							
<i>Neocalanus plumchrus/flemingeri</i>	62.5	93.8	93.8	97.2	100.0	88.5	83.7
<i>N. cristatus</i>	45.8	100.0	93.8	74.6	75.0	96.2	97.7
<i>Calanus pacifica</i>			4.2				
<i>Pachyptilus pacifica</i>							14.0
<i>Pareuchta birostrata</i>							18.6
<i>Lophotrix frontinalis</i>							2.3
Unid. Copepoda	20.8		2.1				
Amphipoda							
Hyperiidea							
<i>Hyperoche medusarum</i>			31.3	62.0			
<i>Parathemisto pacifica</i>	16.7	12.5	6.3	2.8	2.8		
<i>Primno macropa</i>	4.2	68.8			36.1	15.4	41.9
Gammaridea							
Talitridae				4.2			
Euphausiacea							
<i>Thysanoessa</i> 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							
<i>Hexagrammos</i> spp.	4.2			6.3			2.3
Unid. fish							
(Plastic - not prey)	4.2						

Table 70. 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

^a 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 1991: \leq 9 days egg to Chick, and 1993: \leq 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).

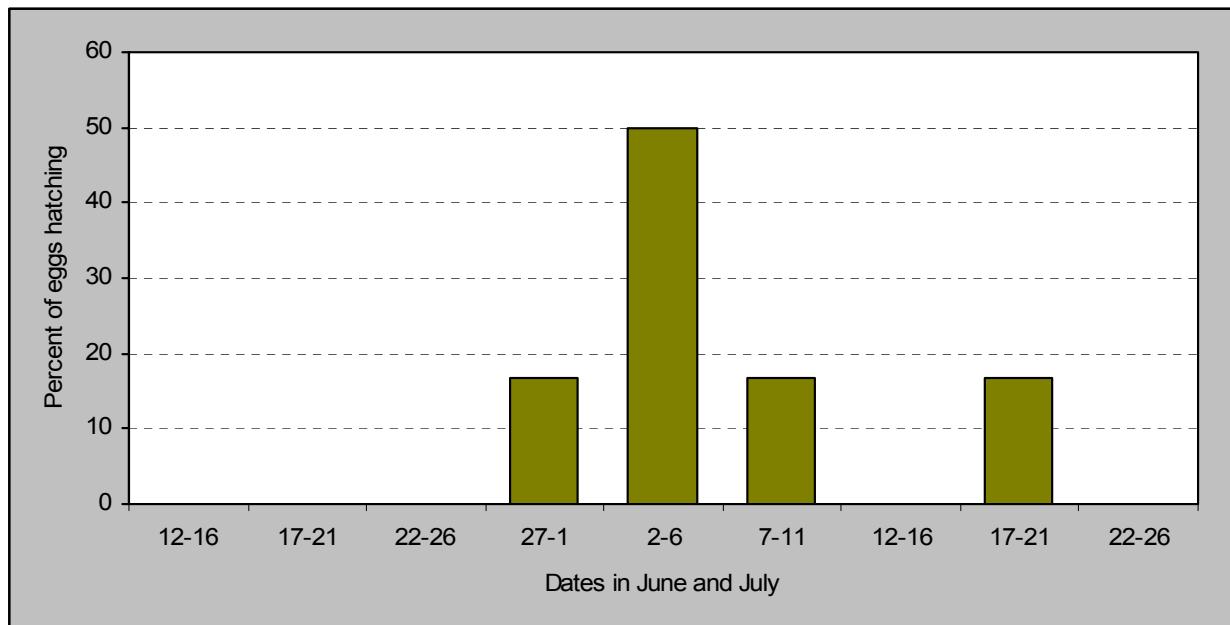


Figure 33. Hatching chronology of parakeet auklets at Buldir Island, Alaska in 2003.

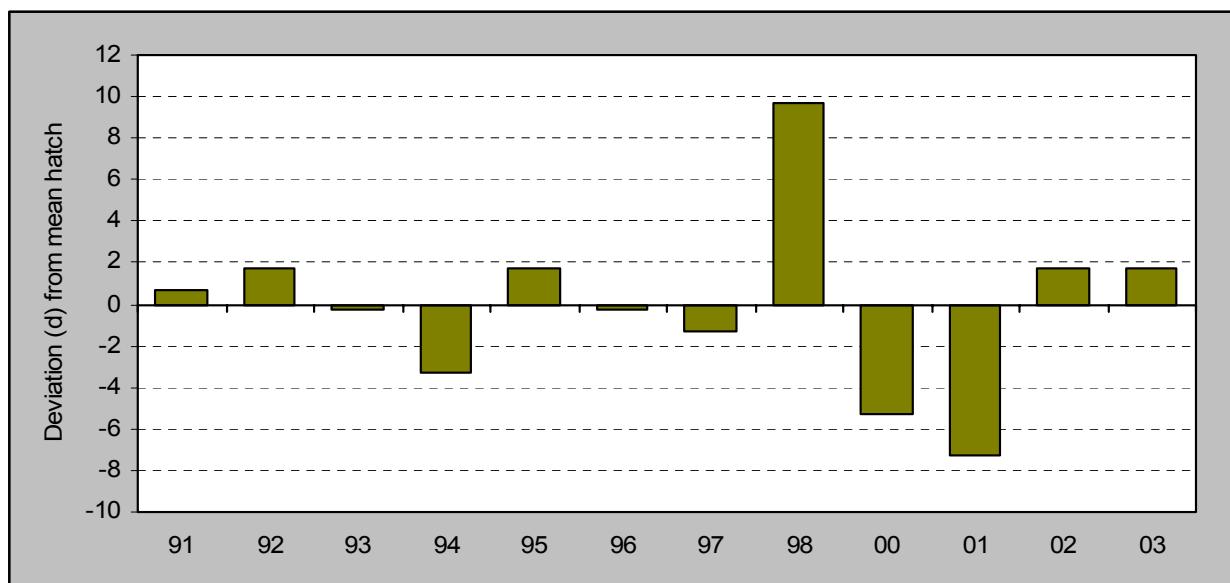


Figure 34. Yearly hatch date deviation (from the 1988-2003 average of 17 July) of parakeet auklets at Buldir Island, Alaska. Numbers below the mean indicate hatch dates earlier; positive numbers indicate hatch dates later.

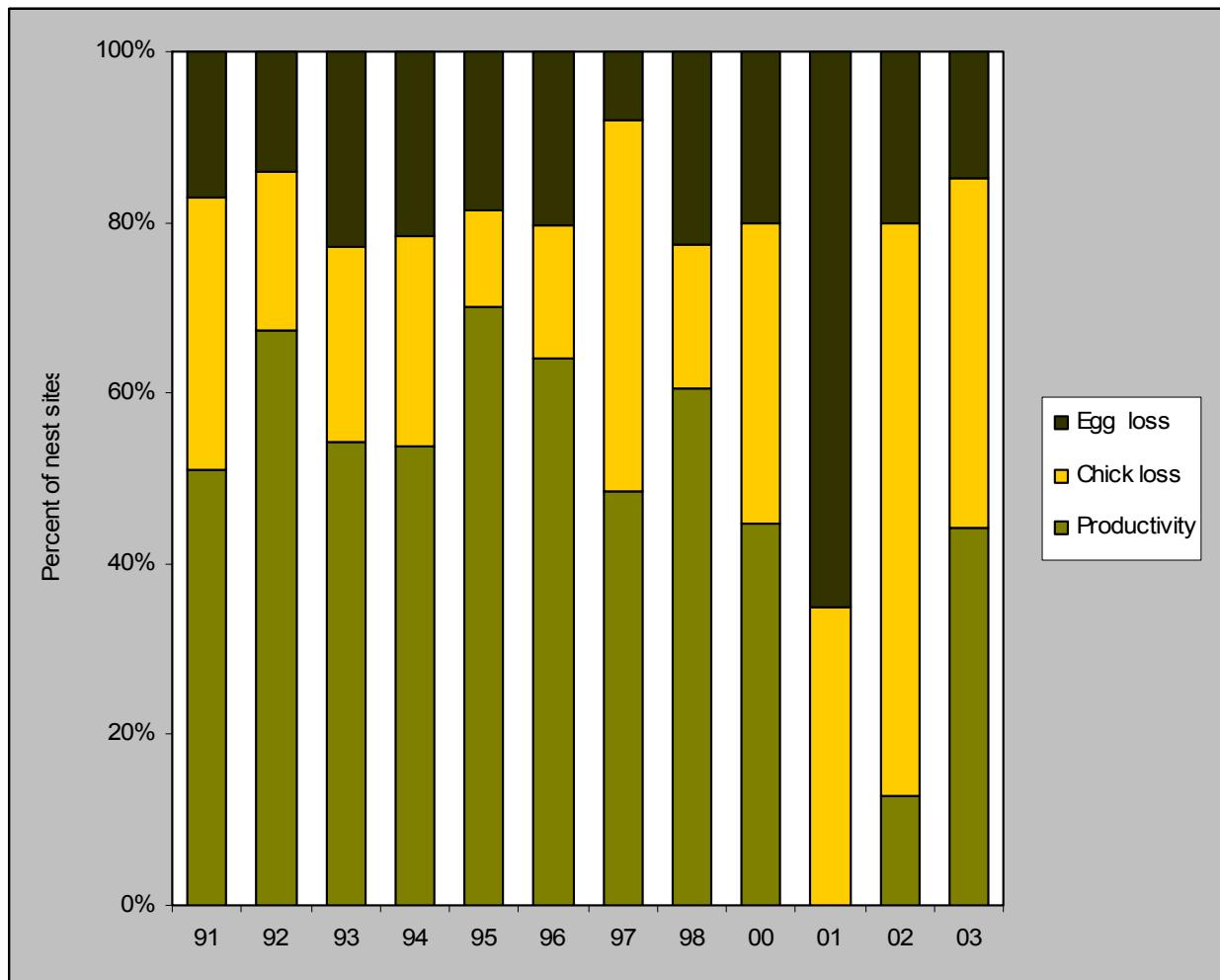


Figure 35. Reproductive performance of parakeet auklets at Buldir Island, Alaska. Egg loss=(A-B)/A; Chick loss=(B-C)/A; Productivity=C/A, where A=number of nest sites, B=number of nest sites with a chick, C=number of sites with fledged chick.

Table 71. Reproductive performance of parakeet auklets at Buldir Island, Alaska.

Parameter ^a	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
No. eggs found (A)	53	43	35	65	70	64	62	71	0	65	40	55	34
No. eggs lost to:													
disappearance	2	3	4	6	5	9	1	11	--	10	8	6	0
abandonment	3	3	3	6	6	3 ^b	2	5	--	3	18	5	5
breakage	4	0	1	2	2	1	2	0	--	0	0	0	0
No. eggs hatched (B)	44	37	27	51	57	51	57	55	--	52	14	44	29
No. chicks lost to:													
disappearance	8	6	7	12	8	2	9	12	--	22	3	6	10
death	9	2	1	4	0	8	18	0	--	1	11	27	4
No. chicks fledged (C)	27	29	19	35	49	41	30	43	--	29	0	7	15
Hatching success (B/A)	0.83	0.86	0.77	0.78	0.81	0.80	0.92	0.77	--	0.80	0.35	0.80	0.85
Fledging success (C/B) ^c	0.61	0.78	0.70	0.69	0.86	0.80	0.53	0.78	--	0.56	0.00	0.16	0.52
Reproductive success (C/A)	0.51	0.67	0.54	0.54	0.70	0.64	0.48	0.61	--	0.45	0.00	0.13	0.44
Productivity (hs x fs)	0.51	0.67	0.54	0.54	0.70	0.64	0.49	0.60	--	0.45	0.00	0.13	0.44

^a Data are from nest sites for which visit intervals at hatching and fledging were ≤ 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.

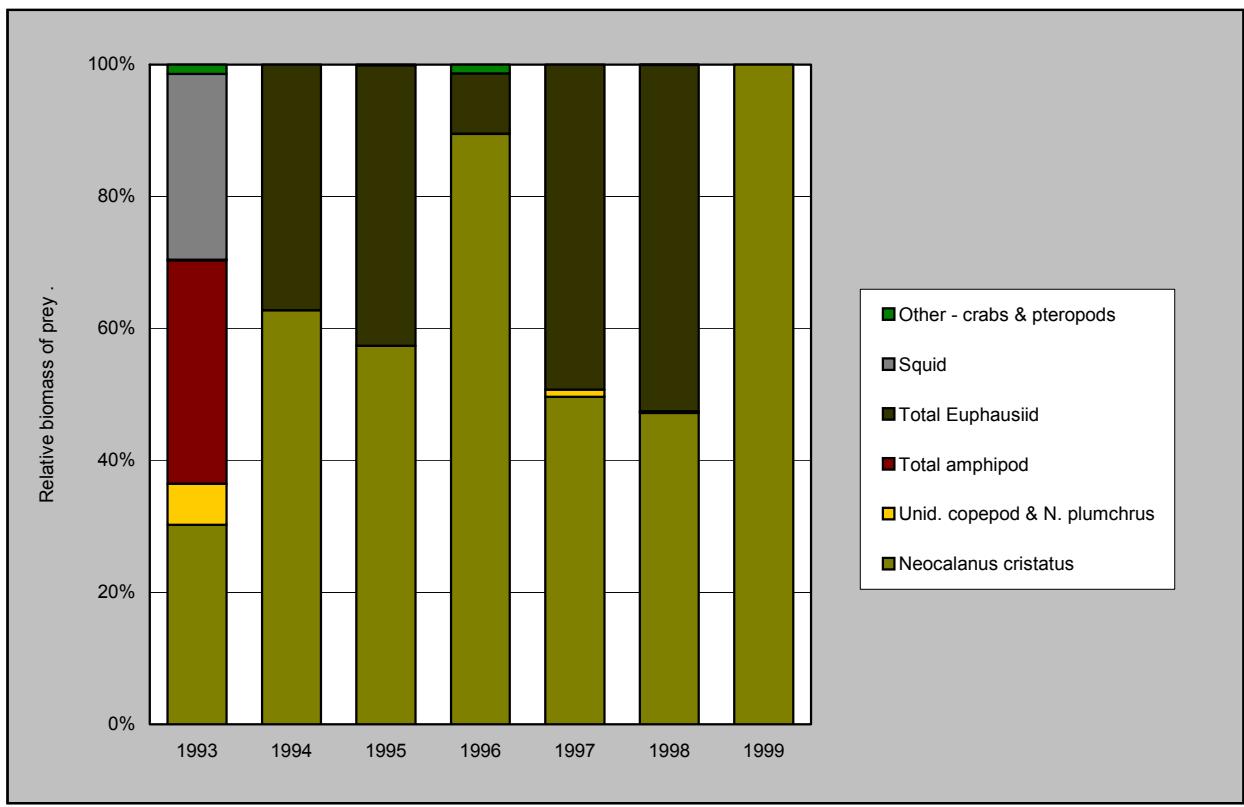


Figure 36. Relative biomass of prey in diets of parakeet auklets at Buldir Island, Alaska.

Table 72. 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							
<i>Neocalanus plumchrus/flemingeri</i>					1.1	<0.1	
<i>N. cristatus</i>	30.3	62.8	57.4	89.2	49.6	43.0	100.0
Unid. Copepoda	6.2						
Amphipoda							
Hyperiidea				<0.1			
<i>Parathemisto pacifica</i>	32.8						
<i>Primno macropa</i>	1.1						
<i>Hyperoche medusarum</i>					0.1		
Gamaridea						0.1	
Lysianassidae							
Euphausiacea							
<i>Thysanoessa</i> spp.	0.1	37.2	42.5	9.5	49.2		
Unid. Euphausiid						47.8	
Decapoda				0.1			
Crab zoea							
Oregoninae	1.4						
Atelecyclidae megalopa						<0.1	

Table 73. 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							
<i>Neocalanus plumchrus/flemingeri</i>					33.3	8.3	
<i>N. cristatus</i>	50.0	66.7	81.3	100.0	66.7	75.0	100.0
Unid. Copepoda	16.7						
Amphipoda							
Hyperiidea				20.0			
<i>Parathemisto pacifica</i>	50.0						
<i>Primno macropa</i>	16.7						
<i>Hyperoche medusarum</i>						8.3	
Gamaridea						8.3	
Lysianassidae							
Euphausiacea							
<i>Thysanoessa</i> spp.	16.7	33.3	43.8	40.0	66.7		
Unid. Euphausiid						83.3	
Decapoda			6.3				
Crab zoea							
Oregoninae	16.7						
Atelecyclidae megalopa						8.3	

Table 74. 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

^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.

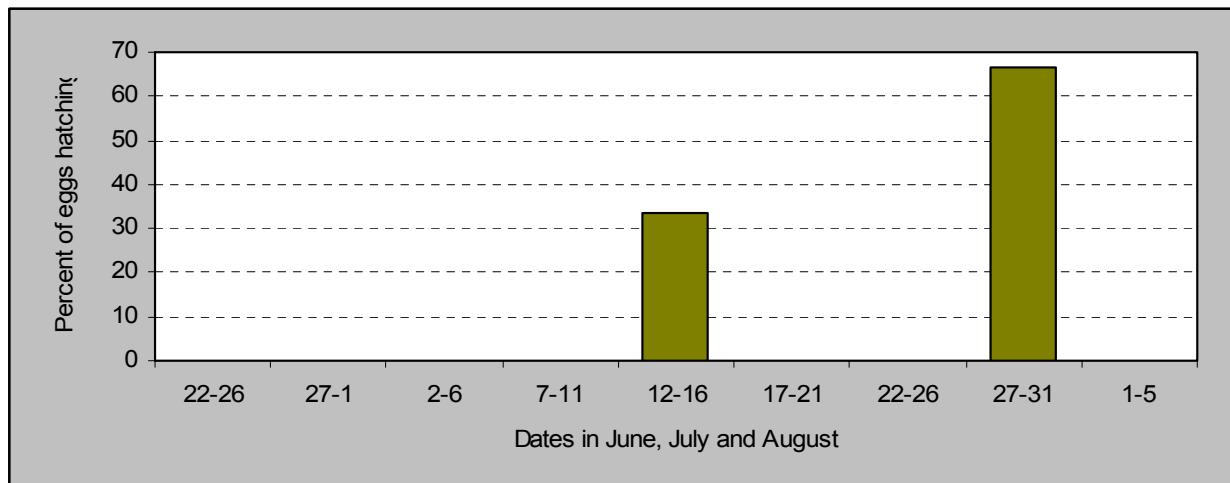


Figure 37. Hatching chronology of tufted puffins at Buldir Island, Alaska in 2003.

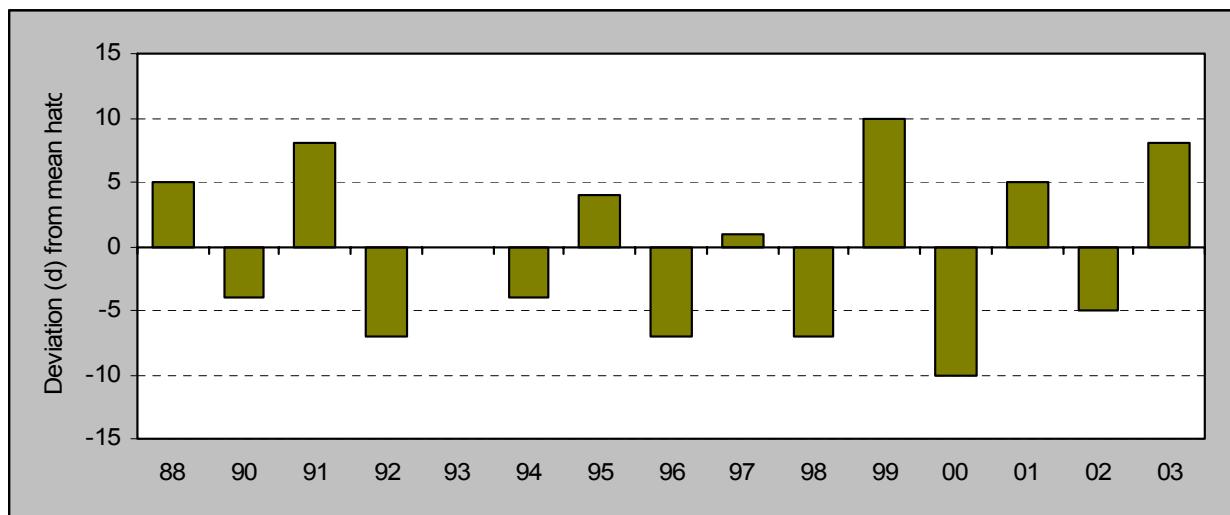


Figure 38. Yearly hatch date deviation (from the 1988-2003 average of 17 July) of tufted puffins at Buldir Island, Alaska. Numbers below the mean indicate hatch dates earlier; positive numbers indicate hatch dates later.

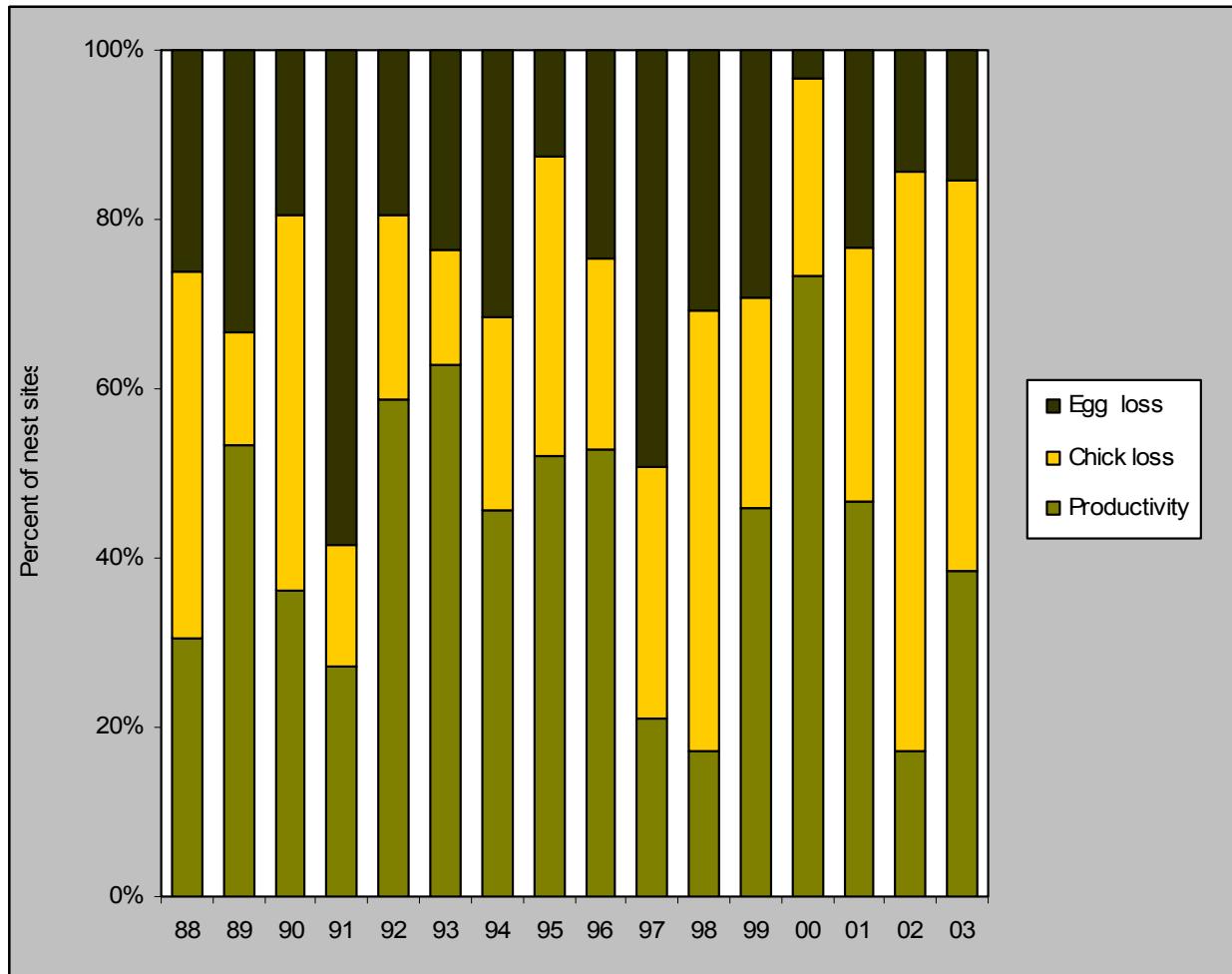


Figure 39. Reproductive performance of tufted puffins at Buldir Island, Alaska. Egg Loss=(A-B)/A; Chick Loss=(B-C)/A; Productivity=C/A, where A=number nest sites, B=number of nest sites with a chick; C=number of nests sites with fledged chick.

Table 75. 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
No. eggs found ^b (A)	23	30	36	77	46	51	35	48	53	57	52	24	30	30	35	13
No. eggs lost to:																
disappearance	2	5	5	23	4	11	7	2	6	18	10	2	0	3	4	2
abandonment	3	4	2	18	5	1	3	0	1	2	6	5	1	4	0	0
breakage	1	1	0	4	0	0	1	4	6	8	0	0	0	0	1	0
No. eggs hatched (B)	17	20	29	32	37	39	24	42	40	29	36	17	29	23	30	11
No. chicks lost to:																
disappearance	2	0	14	9	7	6	6	13	6	11	15	6	7	6	14	4
death	8	4	2	2	3	1	2	4	6	6	12	2	0	3	10	2
No. "successful" chicks (C ₁₊₂)	7	16	13	21	27	32	16	25	28	12	9	11	22	14	6	5
fledged ^c (C ₁)	6	6	7	2	9	30	15	8	25	8	0	1	2	2	2	3
still present (C ₂)	1	10	6	19	18	2	1	17	3	4	9	10	20	12	4	2
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
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
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
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

^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 \pm half the visit interval).

^b 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.

^c 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.

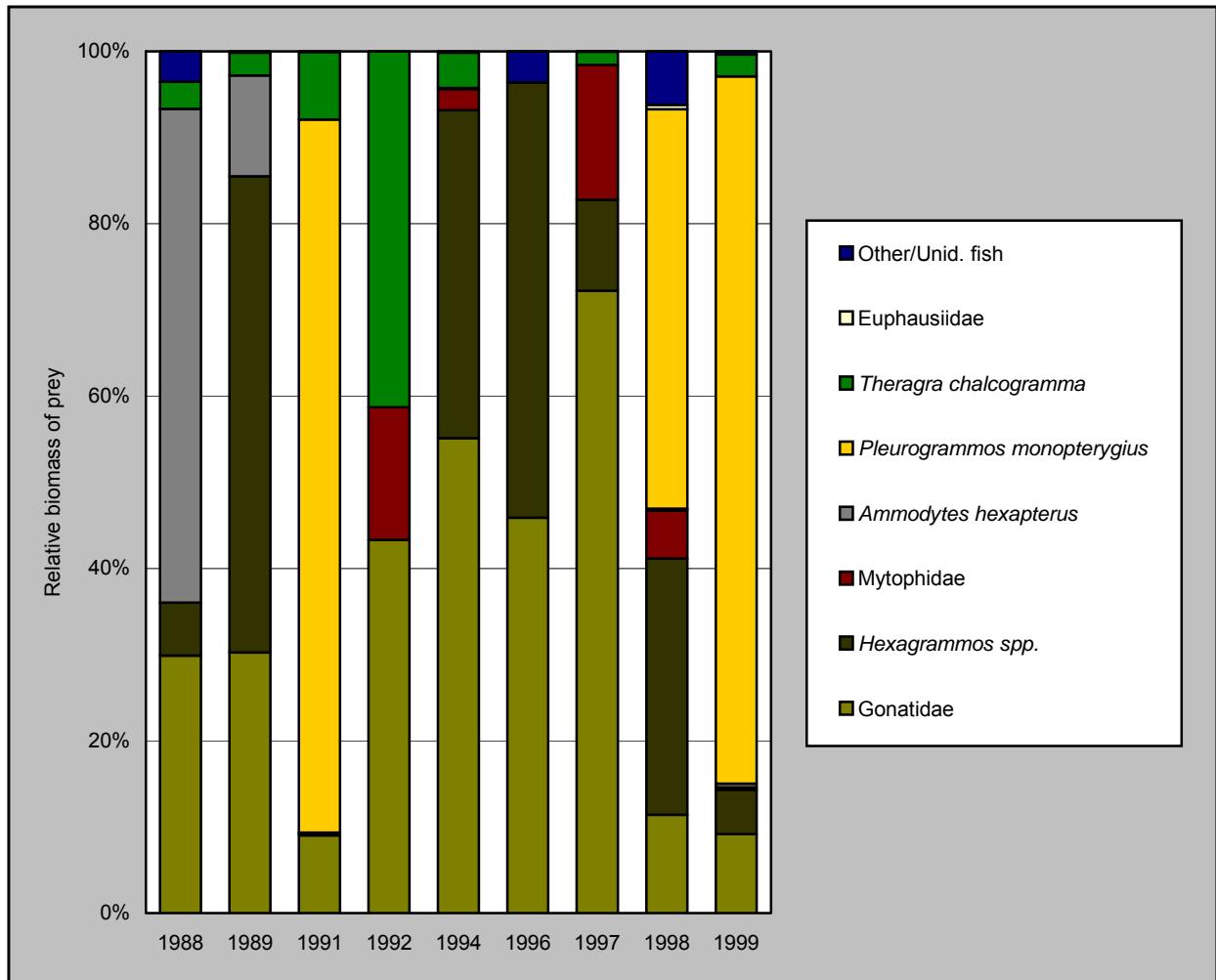


Figure 40. Relative biomass of prey in diets of tufted puffins at Buldir Island, Alaska.

Table 76. 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 end	12 Aug 5 Sep	25 Jul 15 Aug	9 Aug 12 Aug	11 Aug 11 Aug	6 Aug 18 Aug	31 Jul 17 Aug	12 Aug 17 Aug	9 Aug 15 Aug	10 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)										
<i>Gonatus middendorffii</i>							32.5	71.8		
<i>Berryteuthis magister</i>							6.7			
<i>Gonatopsis makko</i>								0.4		
Unid. squid		29.9	30.2	9.0	43.3	55.1	6.6		11.4	9.2
Euphausiidae										
<i>Thysanoessa longipes</i>								0.4		
<i>Thysanoessa</i> spp.								0.2		
Fish										
Myctophidae										
<i>Stenobrachius leucopsarus</i>							15.6	1.8		
Unid. Myctophidae					15.4	2.4		3.8	0.3	
Gadidae										
<i>Theragra chalcogramma</i>	3.2	2.7	7.8	41.3	4.1		1.5			
Ptilichthyidae			0.1					0.1		
Zaproridae									0.1	
<i>Zaprora silenus</i>										0.1
Ammodytidae										
<i>Ammodytes hexapterus</i>	57.3	11.7	0.1		0.2			0.2	0.5	
Scorpaenidae							1.4		0.1	
Anoplopomatidae										
<i>Anoplopoma fimbria</i>							0.4			
Hexagrammidae										
<i>Hexagrammos decagrammus</i>					38.1	49.8	10.6	29.7	23.8	
<i>Hexagrammos</i> spp.	6.2	55.3	0.2			0.8				
<i>Pleurogrammos monopterygius</i>			82.8					46.4	82.1	
Cottidae										
<i>Hemilepidotus</i> spp.						0.6				
<i>Blepsias bilobus</i>								0.4	1.3	
Pleuronectidae							0.1	0.4	0.2	
Unid. fish	3.5		0.1				0.8		5.5	

Table 77. 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)										
<i>Gonatus middendorffii</i>							29.4	84.6		
<i>Berryteuthis magister</i>							5.9			
<i>Gonatopsis makko</i>								7.7		
Unid. squid	38.5	50.0	69.6	33.3	50.0	75.0	5.9		31.0	12.9
Euphausiidae										
<i>Thysanoessa longipes</i>								3.4		
<i>Thysanoessa</i> spp.								6.9		
Decapoda - shrimp	2.6									
Fish										
Myctophidae										
<i>Stenobrachius leucopsarus</i>								7.7	3.4	
Unid. Myctophidae					25.0	7.5		6.9	3.2	
Gadidae										
<i>Theragra chalcogramma</i>	10.3	11.5	8.7	28.6	75.0	22.5		23.1		19.4
Ptilichthyidae			3.8						3.4	
Zaproridae										3.2
<i>Zaprora silenus</i>										
Ammodytidae										
<i>Ammodytes hexapterus</i>	79.5	26.9	4.3	4.8		2.5			3.4	9.7
Scorpaenidae							17.6		3.4	
Anoplopomatidae										
<i>Anoplopoma fimbria</i>							5.9			
Hexagrammidae										
<i>Hexagrammos decagrammus</i>						30.0	47.1	15.4	51.7	25.8
<i>Hexagrammos</i> spp.	12.8	61.5		4.8			11.8			
<i>Pleurogrammos monopterygius</i>			26.1	59.5					27.6	61.3
Cottidae										
<i>Hemilepidotus</i> spp.							11.8		3.4	
<i>Blepsias bilobus</i>									3.4	3.2
Pleuronectidae										
Unid. fish	17.9		4.3	4.8		7.5	5.9	7.7	17.2	

Table 78. 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)										
<i>Gonatus middendorffii</i>							22.7	75.6		
<i>Berryteuthis magister</i>							1.5			
<i>Gonatopsis makko</i>								2.2		
Unid. squid	10.5	23.3	82.9	31.9	27.3	58.1	3.0		23.9	19.5
Euphausiidae										
<i>Thysanoessa longipes</i>									13.6	
<i>Thysanoessa</i> spp.									10.2	
Decapoda - shrimp	0.4									
Fish										
Myctophidae										
<i>Stenobrachius leucopsarus</i>							6.7	1.1		
Unid. Myctophidae					4.5	2.3			2.3	1.1
Gadidae										
<i>Theragra chalcogramma</i>	3.9	6.7	7.7	39.8	68.2	20.2		8.9		25.3
Ptilichthyidae				0.6					1.1	
<i>Ptilichthys goodei</i>										
Zaproridae										
<i>Zaprora silenus</i>										1.1
Ammodytidae										
<i>Ammodytes hexapterus</i>	76.0	42.3	2.6	1.2		1.6			1.1	3.4
Scorpaenidae							18.2		1.1	
Anoplopomatidae										
<i>Anoplopoma fimbria</i>							1.5			
Hexagrammidae										
<i>Hexagrammos decagrammus</i>						15.5	27.3	4.4	22.7	10.3
<i>Hexagrammos</i> spp.	4.3	27.0		1.2			4.5			
<i>Pleurogrammos monopterygius</i>			6.0	22.3					12.5	37.9
Cottidae										
<i>Hemilepidotus</i> spp.							6.1			
<i>Blepsias bilobus</i>									1.1	1.1
Pleuronectidae										
Unid. fish	5.0		0.9	3.6		2.3	4.5	2.2	2.3	6.8

Table 79. 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

^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 “>”.

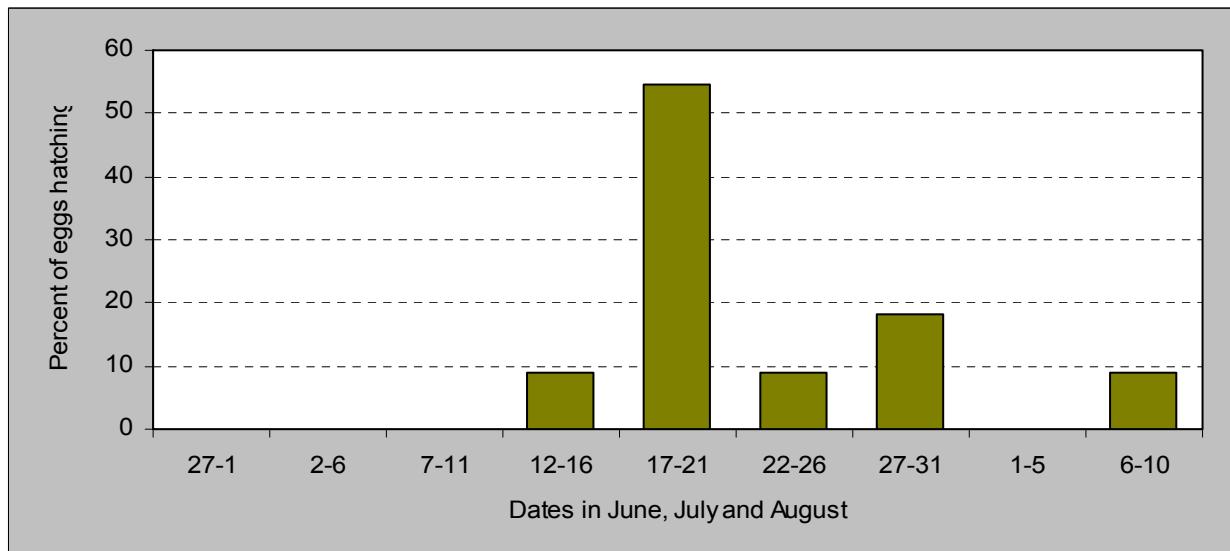


Figure 41. Hatching chronology of horned puffins at Buldir Island, Alaska in 2003.

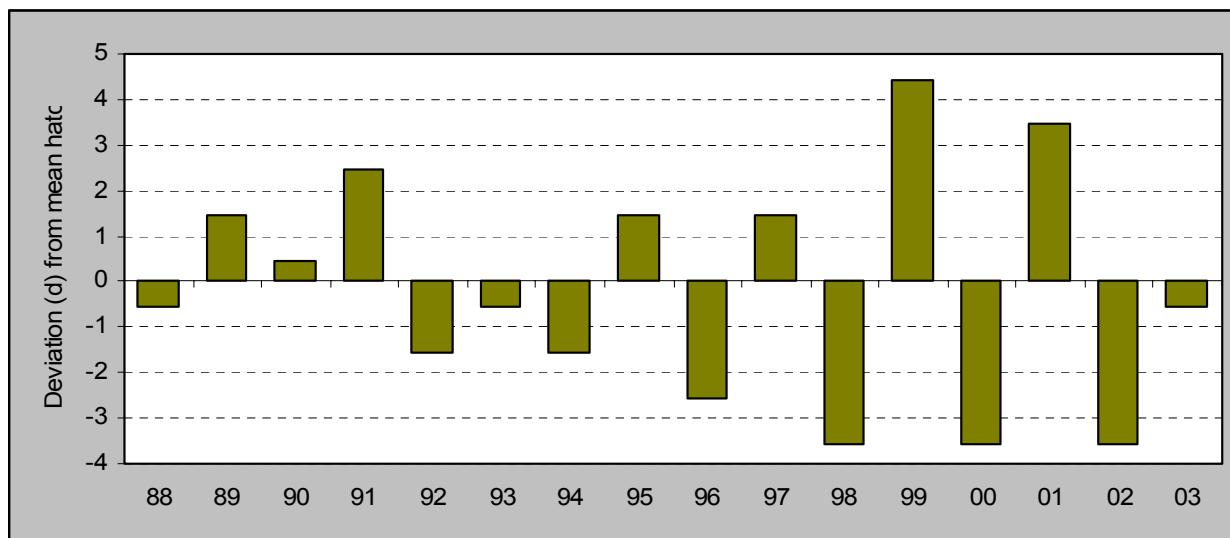


Figure 42. Yearly hatch date deviation (from the 1988-2003 average of 17 July) of horned puffins at Buldir Island, Alaska. Numbers below the mean indicate hatch dates earlier; positive numbers indicate hatch dates later.

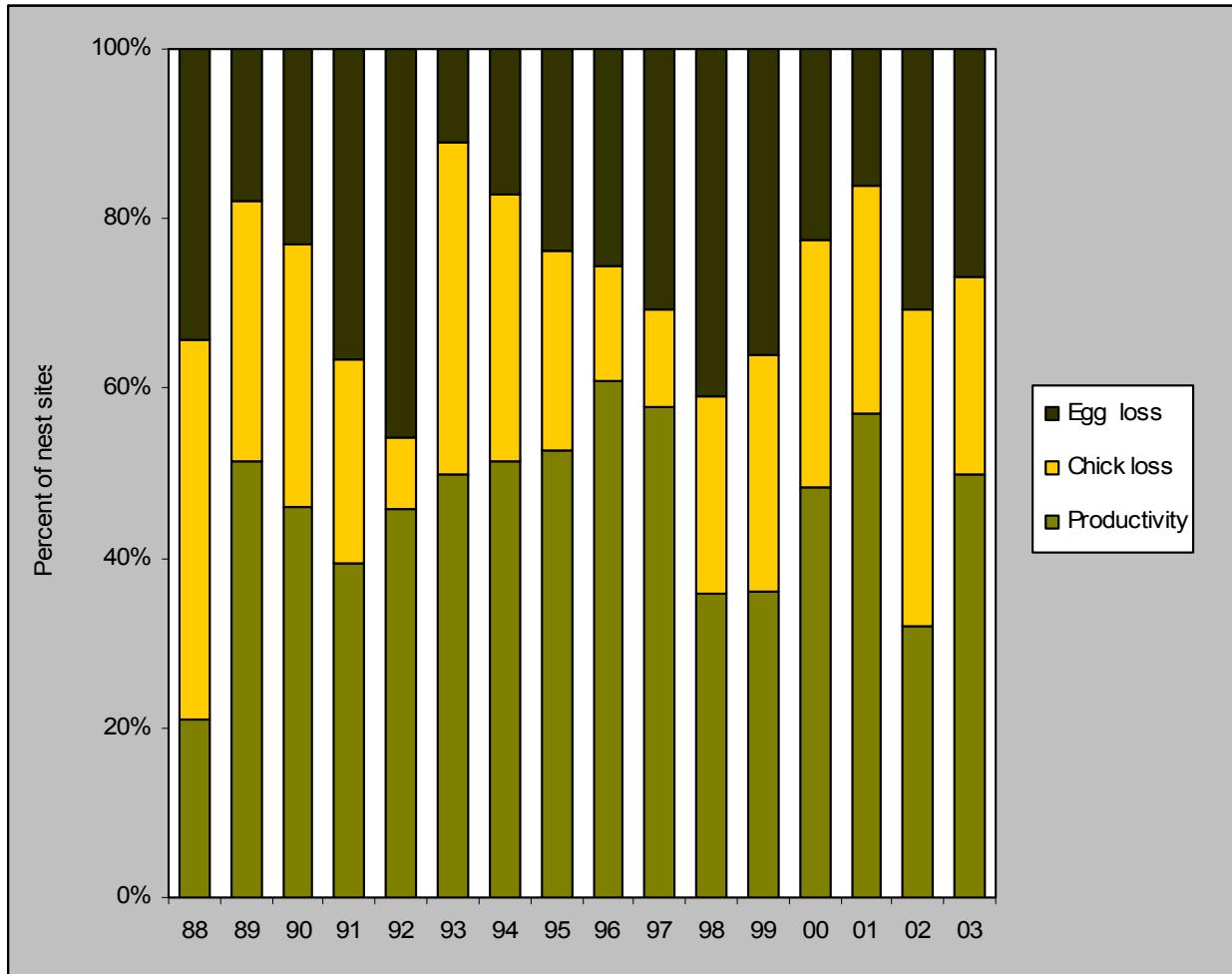


Figure 43. Reproductive performance of horned puffins at Buldir Island, Alaska. Egg Loss=(A-B)/A; Chick Loss=(B-C)/A; Productivity=C/A, where A=number nest sites, B=number of nest sites with a chick; C=number of nests sites with fledged chick.

Table 80. 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
No. eggs found (A)	38	39	52	71	24	18	35	38	51	52	39	25	62	56	91	26
No. eggs lost to:																
disappearance	11	4	12	11	9	2	5	6	8	11	8	7	14	5	14	5
abandonment	2	2	0	11	1	0	0	1	1	2	7	0	0	4	3	1
breakage (%)	0	1	0	4	1	0	1	2	4	3	1	2	0	0	11	1
No. eggs hatched (B)	25	32	40	45	13	16	29	29	38	36	23	16	48	47	63	19
No. chicks lost to:																
disappearance	12	9	13	9	0	5	7	5	3	5	5	6	16	4	21	3
death	5	3	3	8	2	2	4	4	4	1	4	1	2	11	13	3
No. "successful" chicks (C ₁₊₂)	8	20	24	28	11	9	18	20	31	30	14	9	30	32	29	13
fledged ^b (C ₁)	8	2	1	0	0	9	18	0	9	2	0	0	2	9	0	2
still present (C ₂)	0	18	23	28	11	0	0	20	22	28	14	9	28	23	29	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
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
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
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

^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 be 34 days old before disappearing or 30 days old at the time of the last.

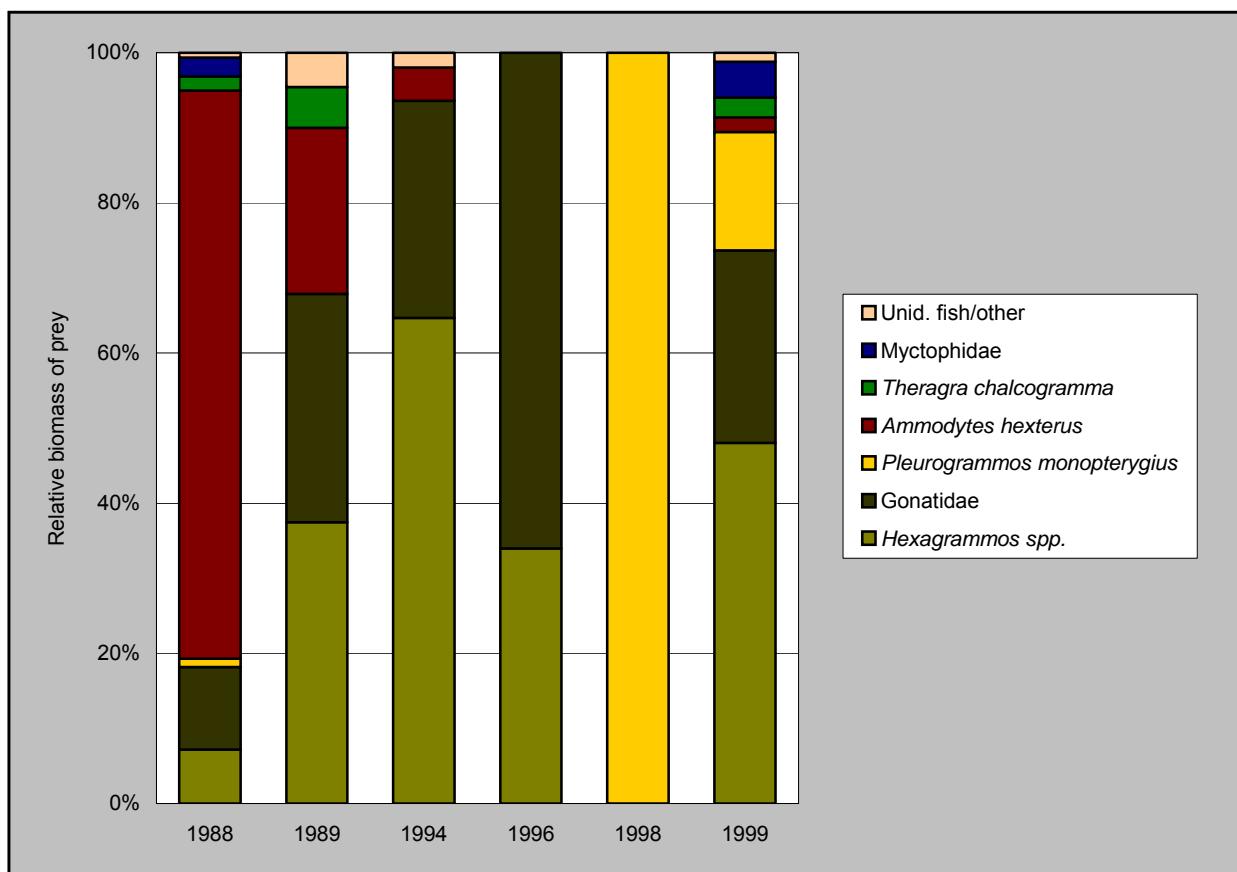


Figure 44. Relative biomass of prey in diets of horned puffins at Buldir Island, Alaska.

Table 81. 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 end	16 Aug 5 Sep	2 Aug 15 Aug	7 Aug 14 Aug	3 Aug 17 Aug	13 Aug 13 Aug	22 Jul 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)						
<i>Gonatus middendorffii</i>				66.0		
Unid. squid	11.0	30.4	28.9			25.7
Fish						
Myctophidae						
<i>Stenobrachius leucopsarus</i>	2.5					4.8
Gadidae						
<i>Theragra chalcogramma</i>	1.9	5.4				2.6
Ammodytidae						
<i>Ammodytes hexapterus</i>	75.7	22.1	4.4			1.9
Hexagrammidae						
<i>Hexagrammos decagrammus</i>			64.7	34.0		42.8
<i>Hexagrammos</i> spp.	7.2	37.5				5.2
<i>Pleurogrammos monopterygius</i>	1.1				100.0	15.8
Agonidae	0.1			2.0		
Pleuronectidae						
Unid. fish	0.5	4.6				1.2

Table 82. 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 end	16 Aug 5 Sep	2 Aug 15 Aug	27 Jul 10 Aug	22 Jul 11 Aug	7 Aug 14 Aug	3 Aug 17 Aug	13 Aug 13 Aug	22 Jul 21 Aug
No. samples		33	16	45	42	3	3	1	28
Gonatidae (squid)									
<i>Gonatus middendorffii</i>							33.3		
Unid. squid		18.2	31.3	20.0	7.1	33.3			31.6
Fish									
Myctophidae									
<i>Stenobrachius leucopsarus</i>		3.0							2.6
Gadidae									
<i>Gadus macrocephalus</i>				2.2					
<i>Theragra chalcogramma</i>		3.0	12.5	17.8	9.5				5.3
Ammodytidae									
<i>Ammodytes hexapterus</i>		93.9	68.8	57.8	45.2	33.3			18.4
Hexagrammidae									
<i>Hexagrammos decagrammus</i>						100.0	66.7		52.6
<i>Hexagrammos</i> spp.		12.1	31.3	4.4	4.8				23.7
<i>Pleurogrammos monopterygius</i>		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 83. 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 end	16 Aug 5 Sep	2 Aug 15 Aug	27 Jul 10 Aug	22 Jul 11 Aug	7 Aug 14 Aug	3 Aug 17 Aug	13 Aug 13 Aug	22 Jul 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)									
<i>Gonatus middendorffii</i>							57.1		
Unid. squid		4.0	32.9	7.7	6.6	28.6			20.1
Fish									
Myctophidae									
<i>Stenobrachius leucopsarus</i>		0.4							2.6
Gadidae									
<i>Gadus macrocephalus</i>				0.4					
<i>Theragra chalcogramma</i>		4.0	5.7	11.1	2.6				3.2
Ammodytidae									
<i>Ammodytes hexapterus</i>		85.3	50.0	61.3	60.2	35.7			8.5
Hexagrammidae									
<i>Hexagrammos decagrammus</i>						21.4	42.9		24.9
<i>Hexagrammos</i> spp.		1.8	8.6	1.1	7.1				31.2
<i>Pleurogrammos monopterygius</i>		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 84. 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. 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 All Years
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

^aTotal number of individuals detected on survey.

Table 85. Numbers of birds detected on off-road point count route number 315, Buldir Island, Alaska, on 14 June 2003.

Species	Point no.												Total ^a	% of total ^b	% of points ^c
	1	2	3	4	5	6	7	8	9	10	11	12			
Aleutian Canada goose	1	21	6	8	16	1	17	6	0	0	0	0	76	49.0	66.7
Parasitic jaeger	0	0	0	0	0	0	0	0	1	0	0	0	1	0.6	8.3
Glaucous-winged gull	3	3	4	5	13	5	0	1	0	0	0	0	34	21.9	58.3
Winter wren	2	2	0	2	0	1	0	0	0	0	0	0	7	4.5	33.3
Song sparrow	1	1	0	0	0	0	0	0	0	0	0	0	2	1.3	16.7
Lapland longspur - total	2	2	5	2	2	1	0	0	2	1	1	0	18	11.6	75.0
male	1	1	2	2	2	1	0	0	2	1	1	0	13	8.4	75.0
female	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
unknown	1	1	3	0	0	0	0	0	0	0	0	0	5	3.2	25.0
Snow bunting	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Rosy finch	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0

^aTotal number of individuals detected on survey.

^bRelative abundance of species: percent of total number of individual birds of all species detected on survey.

^cPercent of points at which species was detected.

^dObserver noted that gulls calling made it hard to hear smaller birds; therefore the number of gulls present was higher than recorded.

Table 86. Counts of sea otters at Buldir Island, Alaska (not conducted in 2003).

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.

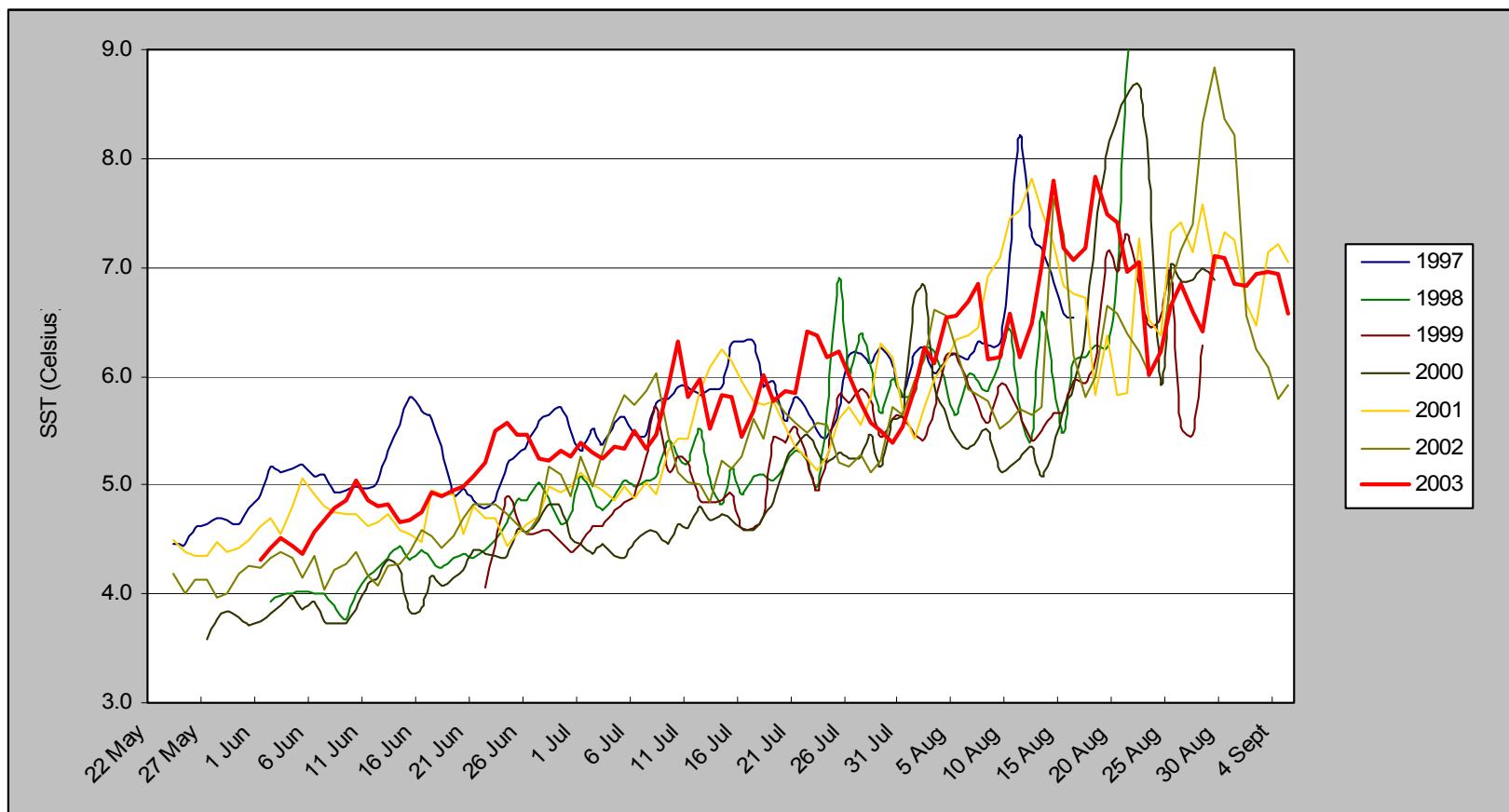


Figure 45. Sea surface temperature (°C) at Buldir Island, Alaska. Values are the daily mean temperature.

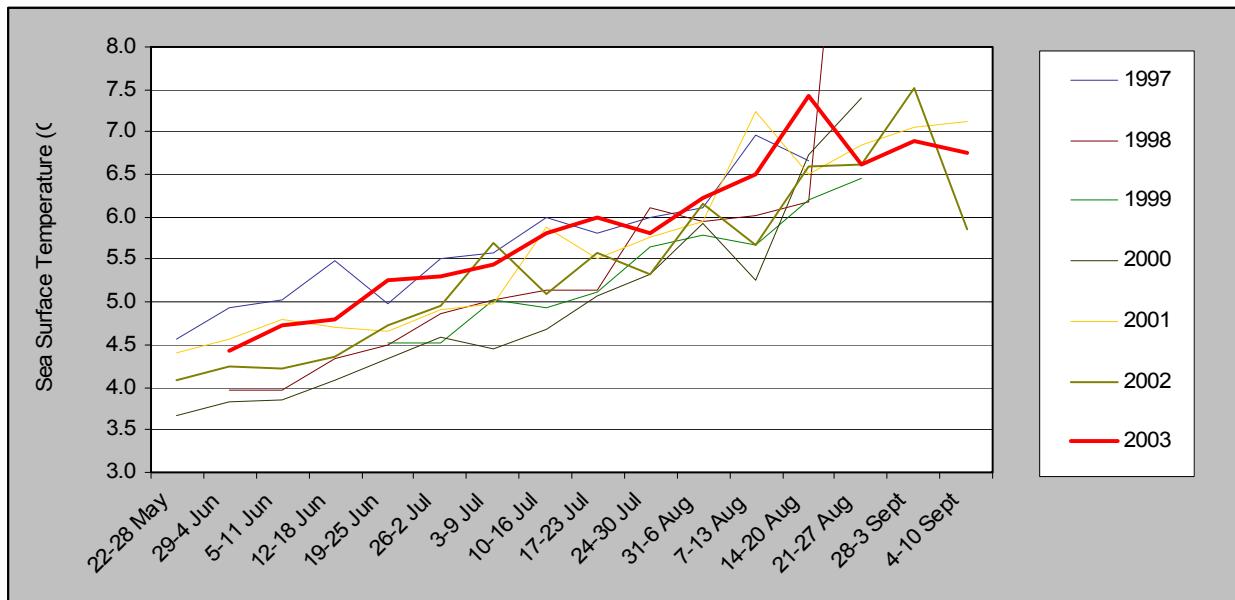


Figure 46. Weekly Sea Surface Temperature (°C) at Buldir Island, Alaska in various years.

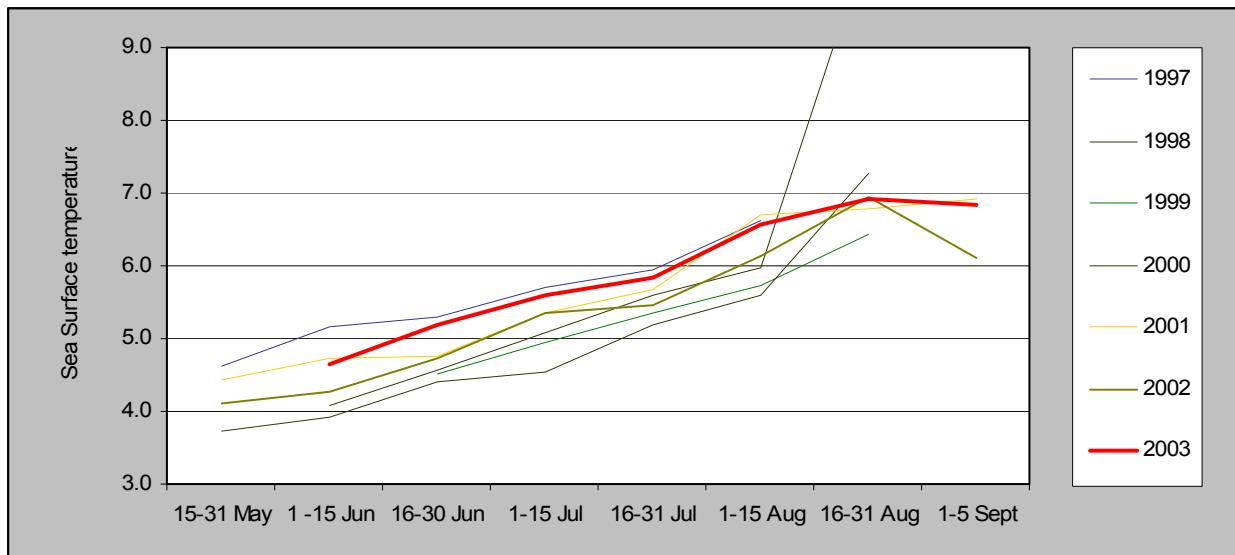


Figure 47. Biweekly Sea Surface Temperature (°C) at Buldir Island, Alaska in various years.

Table 87. Biweekly mean SST ($^{\circ}\text{C}$) at Buldir Island, Alaska. Composite of mean daily temperatures.

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

Table 88. Weekly mean SST ($^{\circ}\text{C}$) at Buldir Island, Alaska. Composite of mean daily temperatures.

Date	1997	1998	1999	2000	2001	2002	2003
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
12-18 Jun	5.5	4.3	--	4.1	4.7	4.4	4.8
19-25 Jun	5.0	4.5	4.5	4.3	4.7	4.7	5.3
26-2 Jul	5.5	4.9	4.5	4.6	4.9	5.0	5.3
3-9 Jul	5.6	5.0	5.0	4.5	5.0	5.7	5.4
10-16 Jul	6.0	5.1	4.9	4.7	5.9	5.1	5.8
17-23 Jul	5.8	5.1	5.1	5.1	5.5	5.6	6.0
24-30 Jul	6.0	6.1	5.7	5.3	5.8	5.3	5.8
31-6 Aug	6.1	6.0	5.8	5.9	6.0	6.2	6.2
7-13 Aug	7.0	6.0	5.7	5.3	7.2	5.7	6.5
14-20 Aug	6.7	6.2	6.2	6.7	6.5	6.6	7.4
21-27 Aug	--	12.7	6.4	7.4	6.8	6.6	6.6
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, 1 June – 5 September 2003.

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*) – Fairly common. Birds were regularly seen throughout the summer from Northwest Ridge.

Northern Fulmar (*Fulmarus glacialis*) – Common. Confirmed Breeder. Nests in small colonies at East Cape, Kittiwake Lane, and Spike Camp. First chick seen on 22 August at Spike Camp. Most birds are dark morphs, but at least one light morph was seen approximately ½ mile offshore Kittiwake Lane, and a few were breeding in vegetated areas on cliffs near Spike Camp.

Fork-tailed Storm-Petrel (*Oceanodroma furcata*) – Abundant. Confirmed breeder. Nests in burrows and crevices over most of the island. Productivity and density were monitored at 6 plots near camp and in 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. A total of 4 nests were monitored at Kittiwake Lane. Known to nest on sea-facing cliffs elsewhere on island.

Aleutian Canada Goose (*Branta canadensis leucopareia*) - Abundant. Confirmed breeder. Present in all vegetated areas except for high alpine. Nests were found on first walk up Glissade Valley on 10 June. Eggs were floated and determined to be 6-8 days old. First goslings were seen on 15 June near Glissade Valley.

Bean Goose (*Anser fabalis*) – Casual. Two individuals were observed flying above South Marsh from Bean Goose Pond on 1 June.

Mallard (*Anas platyrhynchos*) – Casual. One male was observed along Tattler Creek 16 June.

Green-winged Teal (*Anas crecca*) – Very rare. Small groups of individuals of both sexes were observed at Bean Goose Pond and the small pond at Spike. They were seen on 1-3 June, and one female was seen on 29 August.

Eurasian Wigeon (*Anas penelope*) – Casual. One individual was seen at Bean Goose Pond on 1 June.

Northern Pintail (*Anas acuta*) – Very rare. Ten individuals were observed on 1 June at South Marsh and one female was observed at South Marsh on 3 June. A pair was seen on 9 June off Northwest Point.

Common Eider (*Somateria mollissima*) – Common. Confirmed breeder. Groups of birds were seen regularly throughout the season. The first chicks were seen off the coast of Northbright Beach trailing behind an adult female. One nest was found in the rocks below Petrel Valley along north coast. It contained 4 eggs on 13 June.

Harlequin Duck (*Histrionicus histrionicus*) – Fairly common. Small groups (<10 birds) were seen consistently between 1 June and 29 August.

Common Merganser (*Mergus merganser*) – Very rare. Seen between 9 – 20 June on cobbles below Northwest Ridge and along Northbright Beach. A single female was found dead on Northbright Beach on 5 June.

Bald Eagle (*Haliaeetus leucocephalus*) – Rare. Confirmed breeder. Both adults and subadults were seen regularly during island crossings between Main Camp and Spike Camp.

Peregrine Falcon (*Falco peregrinus*) – Fairly common. Confirmed breeder. The same two aeries as in 2001 were active in 2002: one at Peregrine Point, and one above North Rocks. Juveniles were observed regularly beginning in mid-July.

Mongolian Plover (*Charadrius mongolus stegmanni*) – Casual. One individual was seen on Northbright Beach on 6 June associated with a Ruddy Turnstone.

Common Ringed Plover (*Charadrius hiaticula*) – Casual. Noted on 1-2 June on Northbright Beach in association with a Ruddy Turnstone.

Pacific Golden Plover (*Pluvialis fulva*) – Casual. One individual was seen on Northbright Beach on 3 September.

Wandering Tattler (*Heteroscelus incanus*) – Casual. Single individuals were seen on 1 June, 29 August, and 3-4 September.

Gray Tailed Tattler (*Heteroscelus brevipes*) – Casual. Single individual was observed on Northbright Beach for a few days surrounding 3 September.

Ruddy Turnstone (*Arenaria interpres*) – Rare. First individuals were seen on 1 June. Observed sporadically throughout June, and then on 2-3 August, and 8 August. Sightings were along Northbright Beach in June and along the top of cliff sections near vegetation at Spike Camp in August.

Sanderling (*Calidris alba*) – Very rare. A single bird was seen on Northbright Beach on 24 August. Single individuals were spotted each day from 1-5 September.

Dowitcher Spp. (*Limnodromus spp.*) – Casual. Unknown whether it was a short or long-billed. Seen briefly on 3 September at Northbright Beach.

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. At least one bird was regularly heard above camp.

Common Black-headed Gull (*Larus ridibundus*) – Casual. A single individual was observed on Northbright Beach on 6 June in winter plumage, and another on 22-25 June. Generally they were seen feeding in the low intertidal zone, away from the crowds of GWGU.

Slaty-backed Gull (*Larus schistisagus*) – Rare. Two birds, one adult and one juvenile, were seen between Gull Slide and Petrel Valley Creek on north coast on 8 June. Sitting separated from other GWGU.

Glaucous-winged Gull (*Larus glaucescens*) – Abundant. Confirmed breeder. Nests were common along north coastline and also inland in grassy areas around Bean Goose Pond, South Marsh, slopes above Glissade Valley, and at the Dip. Many nests contained hatchlings upon first date of examination in first and second weeks of June. As in previous years, large numbers (>200) of adults and juveniles gathered at Northbight Beach during August.

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.

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.

Thick-billed Murre (*Uria lomvia*) – Abundant. Confirmed breeder. Nests at East Cape, Kittiwake Lane, Spike Camp and on Middle and Outer Rocks.

Pigeon Guillemot (*Cephus columba*) – Common. Confirmed breeder. Birds were regularly seen just offshore all along the North and East coasts.

Ancient Murrelet (*Synthliboramphus antiquus*) – Abundant. Confirmed breeder. First fledgeling was observed at 0300 hrs on 4 July. Last fledgling was observed going downstream in Tattler Creek at 1830 hrs on 23 July. Peak fledging period was between 7-15 July. Stray chicks were frequently found alone in the grasses around main camp during daylight hours, but on 18 July at 0200 hrs an adult was found walking with a chick towards the sea near main camp.

Cassin's Auklet (*Ptychoramphus aleuticus*) – Abundant. Confirmed breeder. Birds were heard and seen while camping at Spike Camp. On 17 July an adult was found during daylight hours in the grass near weatherport at main camp.

Parakeet Auklet (*Cyclorrhynchus psittacula*) – Abundant. Confirmed breeder. Nests in talus areas at Northwest Ridge, Spike Camp Valley, and in smaller numbers at Main Talus, and Crested Point. Fledglings were frequently found wandering aimlessly about the camp area at Spike Camp. Most died within 36 hours. A high count of 6 dead fledglings was recorded at Spike Camp on 2 August.

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.

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

Common Cuckoo (*Cuculus canorus*) – Casual. A single individual was observed on 7 June along Tattler Creek by main camp, and single dead birds were found on 9 June below Northwest Ridge, and on 25 July along the base of Gull Slide.

Short-eared Owl (*Asio flammeus*) – Likely Casual visitor. Single individuals were seen briefly on 15 June, and again on 28 July at North Marsh, though positive ID could not be made.

Siberian Flycatcher (*Muscicapa siberica*) – Casual. Two individuals were seen during the first week of June.

Gray-spotted Flycatcher (*Muscicapa griseisticta*) – Casual. Two individuals were seen during the first week of June.

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

Middendorf's Grasshopper Warbler (*Locustella ochotensis*) – Casual. A single individual was observed on 7 June along Tattler Creek drainage near camp.

Eyebrowed Thrush (*Turdus obscurus*) – Casual. More than one individual was observed throughout the first week of June.

Northern Wheatear (*Oenanthe oenanthe*) – Casual. A single individual was observed on Northbright beach on 29 August.

Siberian Rubythroat (*Luscinia calliope*) – Casual. Individuals were observed throughout the first week of June.

Yellow Wagtail (*Motacilla flava*) – Casual. Individuals were observed on 3 and 11 June along Tattler Creek in North Marsh and near The Dip above Spike Camp, respectively.

Gray Wagtail (*Motacilla cinerea*) – Casual. An individual was observed on 3 June near Main Camp.

Song Sparrow (*Melospiza melodia*) – Abundant. Confirmed breeder. Commonly seen at lower altitudes, especially near coast.

Lapland Longspur (*Calcarius lapponicus*) – Abundant. Confirmed breeder. Commonly seen in all vegetation habitats 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.

Grey-crowned Rosy Finch (*Leucosticte arctoa*) – Fairly common. Confirmed breeder. Commonly seen in all lowland vegetated communities as well as on cobble beaches.

Brambling (*Fringilla montifringilla*) – Casual. Individuals were observed along Tattler Creek in North Marsh and along cobbles at storm tideline on Northbright beach throughout first week of June.

Hawfinch (*Coccothraustes coccothraustes*) – Casual. Individuals were observed along Tattler Creek in North Marsh and along cobbles at storm tideline on Northbright beach throughout first week of June, and again 17 – 19 June.

Marine Mammals

Sea Otter (*Enhydra lutris*) – Rare. Occasionally seen in the nearshore waters off Main Talus, Kittiwake Lane, and Spike Camp throughout the summer.

Harbor Seal (*Phoca vitulina*) – Fairly common. Individuals and groups of up to 4 animals were seen throughout the season.

Steller Sea Lion (*Eumetopias jubatus*) – Fairly common. Solitary animals or small groups of up to 7 were seen regularly throughout the season.

Sperm Whale (*Physeter macrocephalus*) – Very Rare. Two individuals were seen diving and spending time along the surface approximately 2 miles off the north shore of the island on 26 June (observations made from the top of Buldir Eccentric), and one single whale was observed on 18 August approximately $\frac{3}{4}$ miles off the north shore (observations made from upper blind Main Talus).