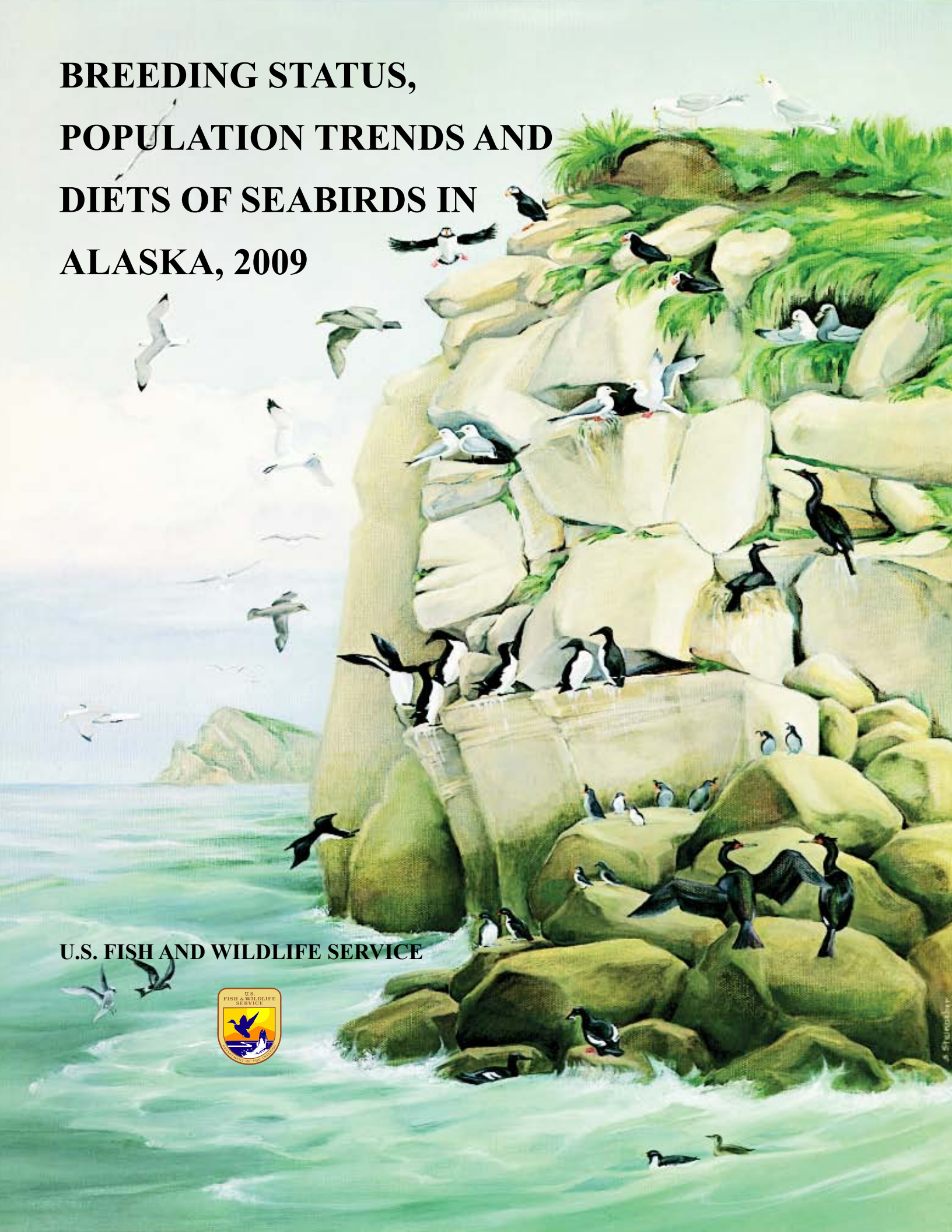
BREEDING STATUS, POPULATION TRENDS AND DIETS OF SEABIRDS IN ALASKA, 2009



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BREEDING STATUS, POPULATION TRENDS AND DIETS OF SEABIRDS IN ALASKA, 2009

Compiled By:

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Executive Summary

Data are collected annually for selected species of marine birds at breeding colonies on the far-flung Alaska Maritime National Wildlife Refuge (NWR), and at other areas in Alaska, to monitor the condition of the marine ecosystem and to evaluate the conservation status of species under the trust of the U. S. Fish and Wildlife Service. The strategy for colony monitoring includes estimating timing of nesting events, rates of reproductive success and population trends of representative species of various foraging guilds (e.g., offshore diving fish-feeders, diving plankton-feeders) at geographically dispersed breeding sites. This information enables managers to better understand ecosystem processes and respond appropriately to resource issues. It also provides a basis for researchers to test hypotheses about ecosystem change. The value of the marine bird monitoring program is enhanced by having sufficiently long time-series to describe patterns for these long-lived species.

In summer 2009 data were gathered on northern fulmars, storm-petrels, cormorants, kittiwakes, glaucous-winged gulls, murres, pigeon guillemots, ancient murrelets, auklets and/or puffins at nine annual monitoring sites on the Alaska Maritime NWR. In addition, data were gathered at other locations which are visited intermittently or were part of a research or monitoring program off refuges.

Timing of breeding (Table A)

- Statewide, the mean hatch date was early for 40% of species and average for 60%.
- Most of the late hatching occurred in the southwestern Bering Sea region.

Table A. Regional and statewide seabird breeding chronology[a] compared to averages for past years within regions and the state of Alaska as a whole. Only sites for which there were data from 2009 are included.

Region	FTSP[b]	LHSP	RFCO	BLKI	RLKI	GWGU	COMU	TBMU	ANMU	PAAU	LEAU	WHAU	CRAU	HOPU	TUPU
SE Bering	↔	↔	↔	↓	↓	↔	↓	↓	↔		↓			↔	↓
SW Bering				↑	↑	↑		↑		↓	↔	↓	↓	↑	↑
N. Gulf of Alaska				↓		↔	↑	↔		↓				↔	↔
Southeast	↓	↔				↓	↔	↔							
Alaska	↓	↔	↔	↓	↔	↔	↔	↔	↔	↓	↓	↓	↓	↔	↔

[a] Codes:
↓ and red cell color indicate hatching chronology was > 3 days earlier than the average.
↔ and yellow cell color indicate hatching chronology was within 3 days of average.
↑ and green cell color indicate hatching chronology was > 3 days later than the average.
[b]FTSP=fork-tailed storm-petrel, LHSP=Leach's storm-petrel, RFCO=red-faced cormorant, BLKI=black-legged kittiwake, RLKI=red-legged kittiwake, GWGU=glaucous-winged gull, COMU=common murre, TBMU=thick-billed murre, ANMU=ancient murrelet, PAAU=parakeet auklet, LEAU=least auklet, WHAU=whiskered auklet, CRAU=crested auklet, HOPU=horned puffin, TUPU=tufted puffin.

Productivity (Table B)

- Statewide, productivity was below average in 12% of species, average in 70% and above average in 18% of species in 2009.
- The highest incidence of poor productivity occurred in the southeastern Bering Sea region.

Table B. Regional and statewide seabird breeding productivity levels[a] compared to averages for past years within regions and the state of Alaska as a whole. Only sites for which there were data from 2009 are included.

Region	FTSP[b]	LHSP	RFCO	PECO	BLKI	RLKI	GWGU	COMU	TBMU	ANMU	PAAU	LEAU	WHAU	CRAU	RHAU	HOPU	TUPU
N. Bering/ Chukchi					↓												
SE Bering	↔	↔	↔	↓	↓	↓	↓	↓	↓	↔		↔				↑	↑
SW Bering	↓	↔	↔	↑	↑	↑	↑		↔		↔	↔	↑	↔		↓	↓
Gulf of Alaska					↓		↔	↔	↔		↔					↔	↔
Southeast	↑	↔		↑			↔	↔	↔						↑		
Alaska	↔	↔	↔	↔	↓	↑	↔	↓	↔	↔	↔	↔	↑	↔	↑	↔	↔

[a] Codes:
↓ and red cell color indicate productivity was > 20% below the average for the region.
↔ and yellow cell color indicate productivity was within 20% of average.
↑ and green cell color indicate productivity was > 20% above the average for the region.
[b] FTSP=fork-tailed storm-petrel, LHSP=Leach's storm-petrel, RFCO=red-faced cormorant, PECO=pelagic cormorant, BLKI=black-legged kittiwake, RLKI=red-legged kittiwake, GWGU=glaucous-winged gull, COMU=common murre, TBMU=thick-billed murre, ANMU=ancient murrelet, PAAU=parakeet auklet, LEAU=least auklet, WHAU=whiskered auklet, CRAU=crested auklet, RHAU=rhinoceros auklet, HOPU=horned puffin, TUPU=tufted puffin.

Recent population trends (Table C)

- Statewide, 31% of species showed declining trends, 56% were stable and 13% increased between 2000 and 2009.
- Between 2000 and 2009, northern fulmars declined in all regions where they were monitored and rhinoceros auklets increased in southeast Alaska.

Table C. Regional and statewide seabird population trends[a] between 2000 and 2009 within regions and the state of Alaska as a whole. Only sites for which there were data from at least two years (at least 5 years apart) within the target decade are included.

Region	NOFU[b]	FTSP	STPE	PECO	UNCO	BLKI	RLKI	GWGU	COMU	TBMU	UNMU	PIGU	LEAU	CRAU	RHAU	TUPU
N. Bering/ Chukchi						↔			↔		↔					
SE Bering	↓		↑	↓	↔	↔	↓	↑	↔	↔	↑		↑			↔
SW Bering				↔	↓	↔	↔	↔		↑	↔	↓	↓	↔		
Gulf of Alaska	↓	↔		↔		↔		↔			↔					↓
Southeast			↔	↓				↑			↔	↔			↑	↔
Alaska	↓	↔	↔	↓	↓	↔	↓	↑	↔	↔	↔	↓	↔	↔	↑	↔

[a] Codes:
↓ and red cell color indicate a negative population trend of ≥3% per annum for this site or region.
↔ and yellow cell color indicate no population trend.
↑ and green cell color indicate a positive population trend of ≥3% per annum for this site or region.
[b] NOFU=northern fulmar, FTSP=fork-tailed storm-petrel, STPE=storm-petrel, PECO=pelagic cormorant, UNCO=unspecified cormorant, BLKI=black-legged kittiwake, RLKI=red-legged kittiwake, GWGU=glaucous-winged gull, COMU=common murre, TBMU=thick-billed murre, UNMU=unspecified murre, PIGU=pigeon guillemot, LEAU=least auklet, CRAU=crested auklet, RHAU=rhinoceros auklet, TUPU=tufted puffin.

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Introduction

This report is the fourteenth in a series of annual reports summarizing the results of seabird monitoring efforts at breeding colonies on the Alaska Maritime National Wildlife Refuge (NWR) and elsewhere in Alaska (see Byrd and Dragoo 1997, Byrd et al. 1998 and 1999, Dragoo et al. 2000, 2001, 2003, 2004 and 2006-2011 for compilations of previous years' data). The seabird monitoring program in Alaska is designed to keep track of selected species of marine birds that indicate changes in the ocean environment. Furthermore, the U. S. Fish and Wildlife Service has the responsibility to conserve seabirds, and monitoring data are used to identify conservation problems. The objective is to provide long-term, time-series data from which biologically significant changes may be detected and from which hypotheses about causes of changes may be tested.

The Alaska Maritime NWR was established specifically to conserve marine bird populations and habitats in their natural diversity and the marine resources upon which they rely and to provide for an international program for research on marine resources (Alaska National Interests Land Conservation Act of 1982). The monitoring program is an integral part of the management of this refuge and provides data that can be used to define "normal" variability in demographic parameters and identify patterns that fall outside norms and thereby constitute potential conservation issues. Although approximately 80% of the seabird nesting colonies in Alaska occur on the Alaska Maritime NWR, marine bird nesting colonies occur on other public lands (e.g., national and state refuges) and on private lands as well.

The strategy for colony monitoring includes estimating timing of nesting events, reproductive success, population trends and prey used by representative species of various foraging guilds (e.g., murres are offshore diving fish-feeders, kittiwakes are offshore surface-feeding fish-feeders, auklets are diving plankton-feeders, etc.) at geographically dispersed breeding sites along the entire coastline of Alaska (Figure 1). A total of nine sites on the Alaska Maritime NWR, located roughly 300-500 km apart, are scheduled for annual surveys (Byrd 2007), and at least some data were available from most of these in 2009. Furthermore, data are recorded annually or semiannually at other sites in Alaska (e.g., Cape Peirce, Togiak NWR). In addition, colonies near the annual sites are identified for less frequent surveys to "calibrate" the information at the annual sites. Data provided from other research projects (e.g., those associated with evaluating the impacts of invasive rodents on marine birds) also supplement the monitoring database.

In this report, we summarize information from 2009 for each species; i.e., tables with estimates of average hatch dates and reproductive success, and maps with symbols indicating the relative timing of hatching and reproductive success at various sites. In addition, historical patterns of hatching chronology and productivity are illustrated for those sites for which we have adequate information. Population trend information is included for sites where adequate data have been gathered. Seabird diet data from several locations are presented as well.

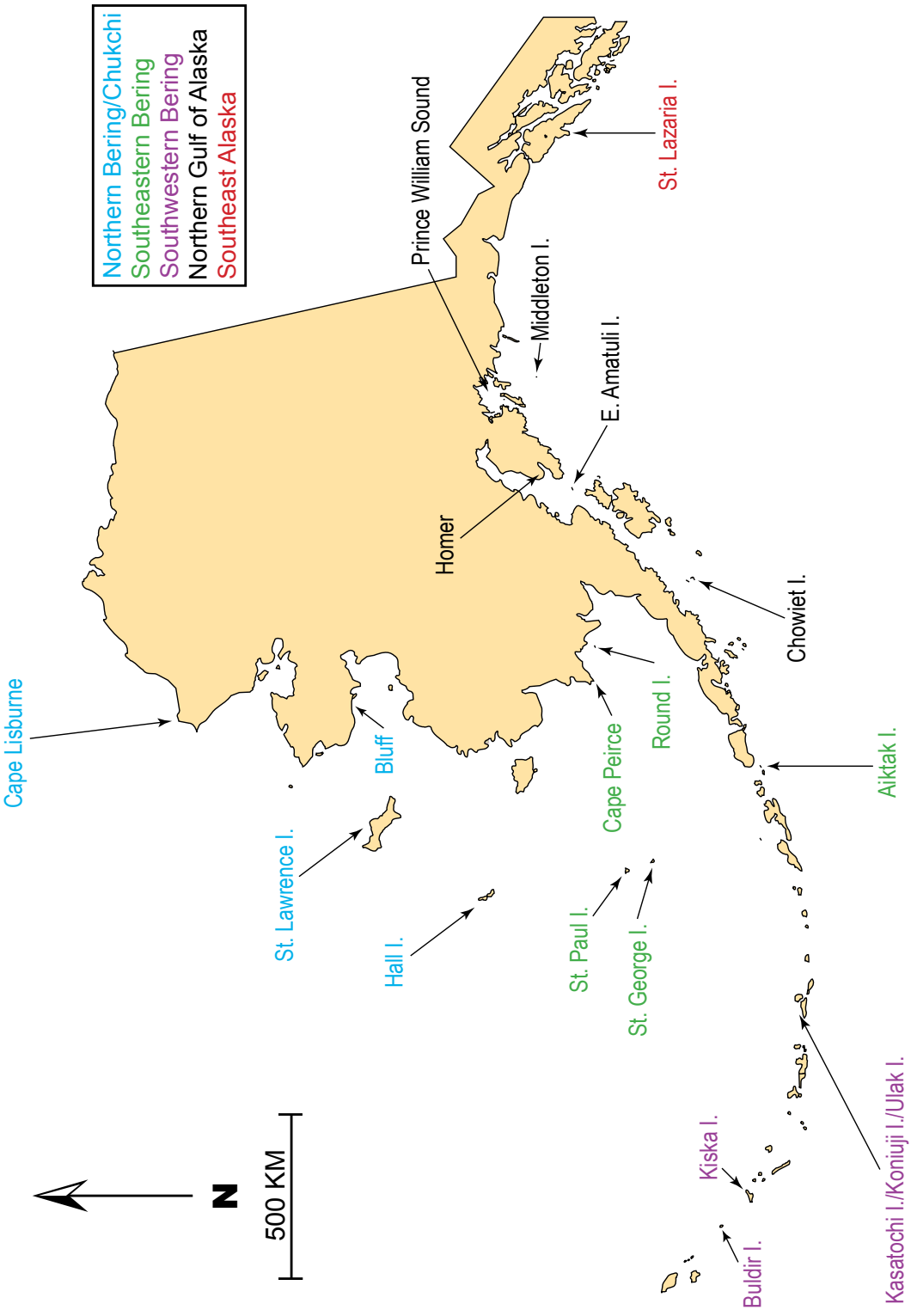


Figure 1. Map of Alaska showing the locations of seabird monitoring sites summarized in this report. Text color indicates geographic regions.

Methods

Data collection methods generally followed protocols specified in "Standard Operating Procedures for Population Inventories" (USFWS 2000*a, b, c*). Timing of nesting events and productivity usually were based on periodic checks of samples of nests (frequently in plots) throughout the breeding season, but a few estimates of productivity were based on single visits to colonies late in the breeding season (as noted in tables). Hatch dates were used to describe nesting chronology. Productivity typically was expressed as chicks fledged per egg, but occasionally other variables were used (Table 1). Population surveys were conducted for ledge-nesting species at times of the day and breeding season when variability in attendance was reduced. Most burrow-nester counts were made early in the season before vegetation obscured burrow entrances. Deviations from standard methods are indicated in reports from individual sites which are appropriately referenced.

Table 1. Productivity parameters used in this report.

Species	Productivity Value
Storm-petrels	Chicks Fledged/Egg (Total chicks fledged/Total eggs)
Cormorants	Chicks Fledged/Nest (Total chicks fledged/Total nests)
Glaucous-winged gull	Hatching Success (Total chicks/Total eggs)
Kittiwakes	Chicks Fledged/Nest (Total chicks fledged/Total nests)
Murres	Chicks Fledged/Nest Site (Total chicks fledged/Total sites where egg was laid)
Ancient murrelet	Chicks Fledged/Egg (Total chicks fledged/Total eggs)
Auklets (except RHAU)	Chicks Fledged/Nest Site (Total chicks fledged/Total sites where egg was laid)
Rhinoceros auklet	Chicks Fledged/Egg (Total chicks fledged/Total eggs)
Puffins	Chicks Fledged/Egg (Total chicks fledged/Total eggs)

This report summarizes monitoring data for 2009, and compares 2009 results with previous years. For sites with at least two years of data prior to 2009, site averages were used for comparisons. For chronology, we considered dates within 3 days of the long-term average to be "normal"; larger deviations represented relatively early or late dates. For productivity, we defined significant deviations from "normal" as any that differed by more than 20% from the site or regional average. Population trends were analyzed using linear regression models on log-transformed data (ln) to calculate the slope of the line. The resultant slope is equivalent to the annual rate of population change. A trend was defined as any change greater than or equal to a three percent per annum increase or decline (≥3% p.a.). Population counts were analyzed using two time frames: 1) data from all available years, and 2) data from the last decade (2000-2009 for this report). A percent per annum change was calculated for each data set during both time periods, if sufficient data were available. We also summarized seabird phenology and productivity, as well as population trends from 2000-2009, by region and for the entire state.

Chronology was calculated for each species in a region using data from all colonies. Each colony was weighted equally within each region. The chronology was averaged for all sites within each region resulting in a value for each species, thus producing one statewide value for each species.

Productivity was calculated for each species in a region using data from all colonies. Each colony was weighted equally within each region The productivity was averaged for all

sites within each region resulting in a value for each species. Species productivities were then averaged to calculate a statewide value for each species.

Population trends were calculated for each species in a region using data from all colonies. Each colony was weighted equally within each region. Trends (line slopes) were averaged for all sites within each region resulting in a regional value for each species. Only sites for which there were data from at least two years (at least 5 years apart) between 2000 and 2009 were included.

Seabird diet information was collected from adult and nestling birds using a variety of methods, including stomach samples from collected birds, regurgitations, bill load observations, gastric lavage and collection of bill loads. Diets of piscivorous birds are reported as percent occurrence, while diets of planktivorous birds (auklets) are reported as percent biomass of prey types.

For diet samples from piscivorous birds, we calculated the percent occurrence for each prey item by dividing the total number of samples in which that prey was recorded by the total number of samples in the data set. When data included stomach samples, we did not include empty stomachs in either the percent occurrence calculations or in the reported sample size for that data set.

We calculated the biomass for each identifiable prey item in each data set by first estimating the mass of that prey item in each sample. We did this by multiplying the count made in the laboratory analysis (often based on extrapolation from a split sample) by the mass of a single individual of that prey type. We used a standard mass for each prey item during the biomass calculations in order to make the results comparable over locations and years (Appendix 1). We then calculated the percent biomass by dividing the total mass of that prey item in the data set by the total estimated masses of all the identified prey items in the data set. In the event that a single prey item was recorded as "present" only, we estimated its mass by calculating the difference between the mass of all other prey items in the sample and the total sample mass measured in the field or in the lab, depending on which sample mass was provided in the data set. If more than one prey item was recorded as "present" only in a single sample, the sample was discarded from the analysis.

Diet results are reported in stacked bar graphs to facilitate viewing several years of data on one graph. For graphs of percent occurrence, the complete stacked bar indicates the cumulative percent occurrence of prey types in the samples and can add up to more than one hundred percent. The cumulative percent occurrence provides information on the average number of prey types per sample. For example, a cumulative percent occurrence of 200% for horned puffins indicates that on average each bird consumed two different prey types during one foraging trip and a cumulative percent occurrence of 100% indicates that on average each bird consumed one prey type during one foraging trip. Only prey that occurred in 5% or more of samples in a given year are displayed in the bar for that year. Taxa appearing in <5% of the samples are grouped in the "other" category.

Diet graph titles include the sample type (chick or adult diet) followed by the collection method. Note that some chick diet information is actually based on samples collected from adults assumed to be carrying chick meals. Sample sizes are reported below each bar. In the event that more than one data type is represented in a single graph, sample sizes for each type are reported below the bars in the graph.

Results

Northern fulmar (*Fulmarus glacialis*)

Breeding chronology.–No data for 2009.

Productivity.–No data for 2009.

Populations.–We found no trends for northern fulmar populations in all years at Hall Island; data were insufficient there to assess recent trends. No trends were evident for all years at St. Paul, St. George or Chowiet islands but fulmar numbers declined at all three colonies between 2000 and 2009 (Figure 2).

Diet.–No data.

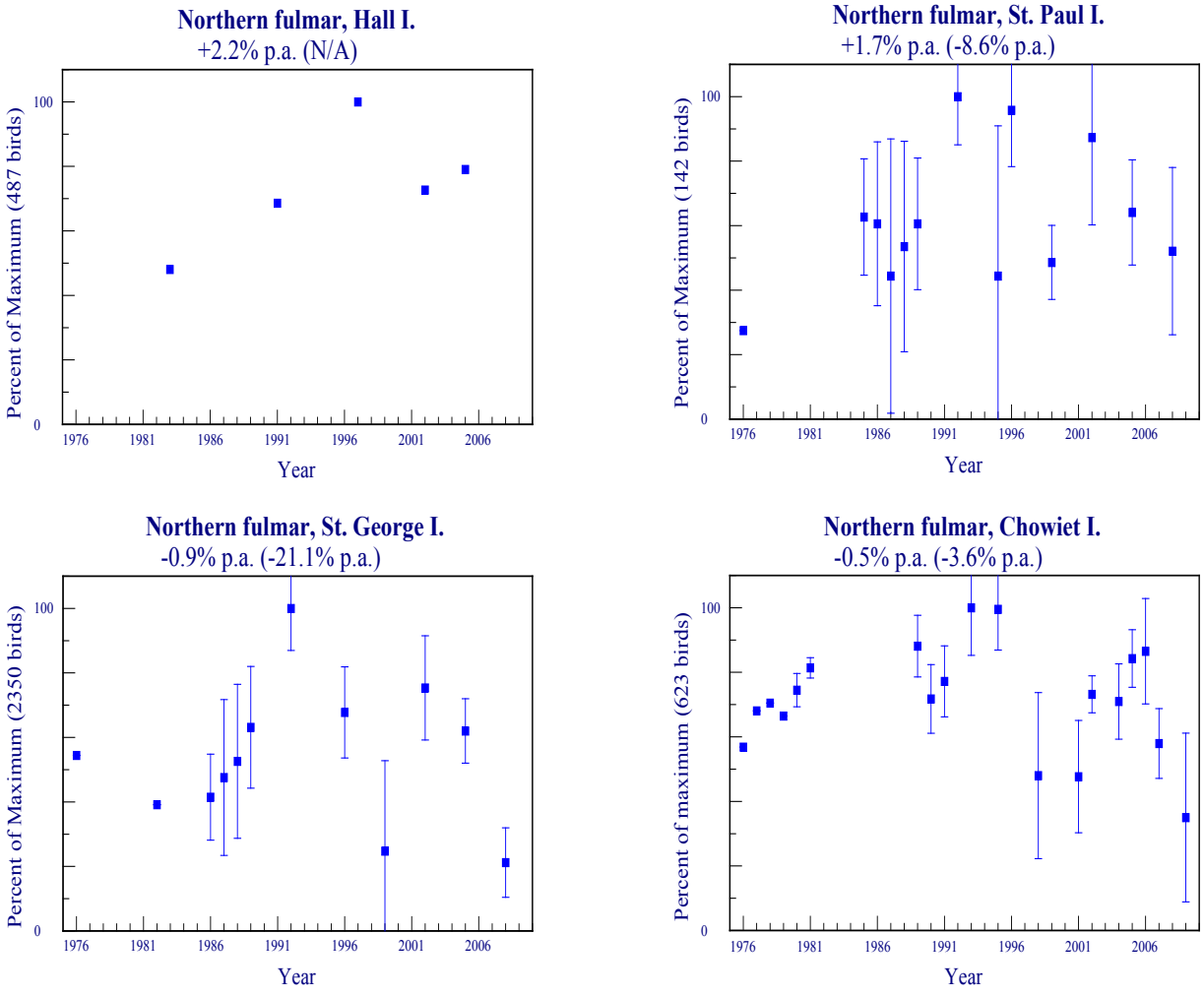


Figure 2. Trends in populations of northern fulmars at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (2000-2009, in parentheses). "N/A" indicates that insufficient data were available.

Fork-tailed storm-petrel (*Oceanodroma furcata*)

Breeding chronology.–The mean hatch date for fork-tailed storm-petrels was average at Aiktak Island and early at St. Lazaria Island in 2009 (Table 2, Figure 3).

Table 2. Hatching chronology of fork-tailed storm-petrels at Alaskan sites monitored in 2009.

Site	Median	Mean	Long-term Average	Reference
Aiktak I.	—	16 Jul (29)[a]	16 Jul[b] (12)[a]	Sapora et al. 2010
St. Lazaria I.	—	3 Jul (37)	13 Jul[b] (14)	L. Slater Unpubl. Data

[a]Sample size in parentheses represents the number of nest sites used to calculate the mean or median hatch date and the number of years used to calculate the long-term average. Current year not included in long-term average.
[b]Mean of annual means.

Productivity.–In 2009, productivity of fork-tailed storm-petrels was low at Buldir Island, about average at Aiktak Island and above average at St. Lazaria Island (Table 3, Figure 4).

Table 3. Reproductive performance of fork-tailed storm-petrels at Alaskan sites monitored in 2009.

Site	Chicks Fledged[a]/Egg	No. of Plots	Long-term Average	Reference
Buldir I.	0.47	5 (68)[b]	0.74 (23)[b]	Freeman et al. 2010
Aiktak I.	0.70	13 (54)	0.82 (9)	Sapora et al. 2010
St. Lazaria I.	0.78	8 (112)	0.63 (13)	L. Slater Unpubl. Data

[a]Fledged chick defined as being alive at last check in August or September.
[b]Sample size in parentheses represents the number of eggs used to calculate productivity and the number of years used to calculate the long-term average. Current year not used in long-term average.

Populations.–Fork-tailed and Leach's storm-petrel burrows were combined at most sites for population monitoring purposes. We found no trends for storm-petrel populations in either all years or between 2000 and 2009 at E. Amatuli or St. Lazaria islands. Storm-petrel numbers increased at Aiktak Island during both time periods (Figure 5).

Diet.–Diets of fork-tailed storm-petrels at Buldir and Kasatochi islands consisted of a majority of myctophids and amphipods (Figure 6). In several small samples from Aiktak Island, diet included amphipods, euphausiids and small fish. Diets from St. Lazaria Island consisted of a majority of myctophids, other larval fish and amphipods.

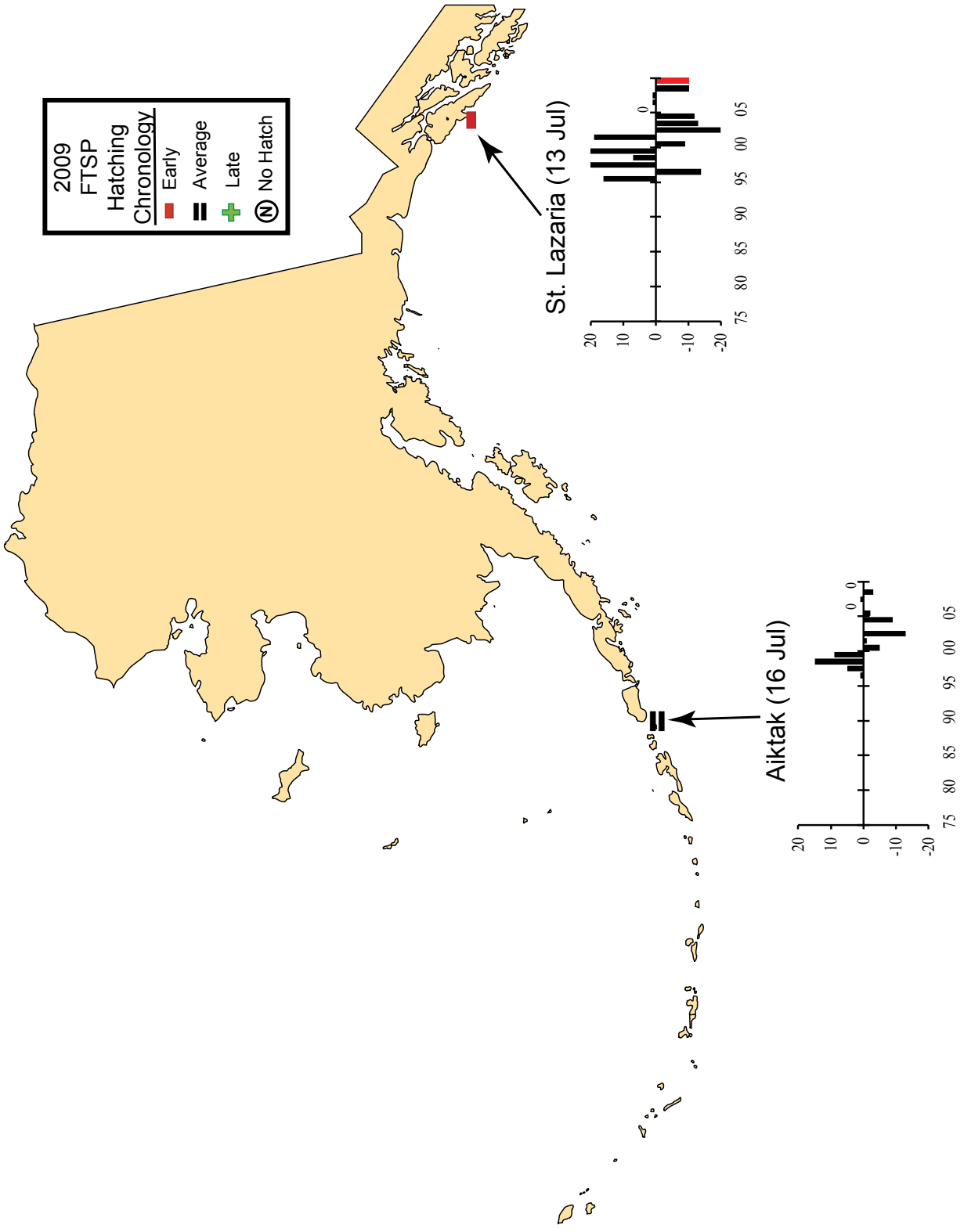


Figure 3. Hatching chronology of fork-tailed storm-petrels at Alaskan sites. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

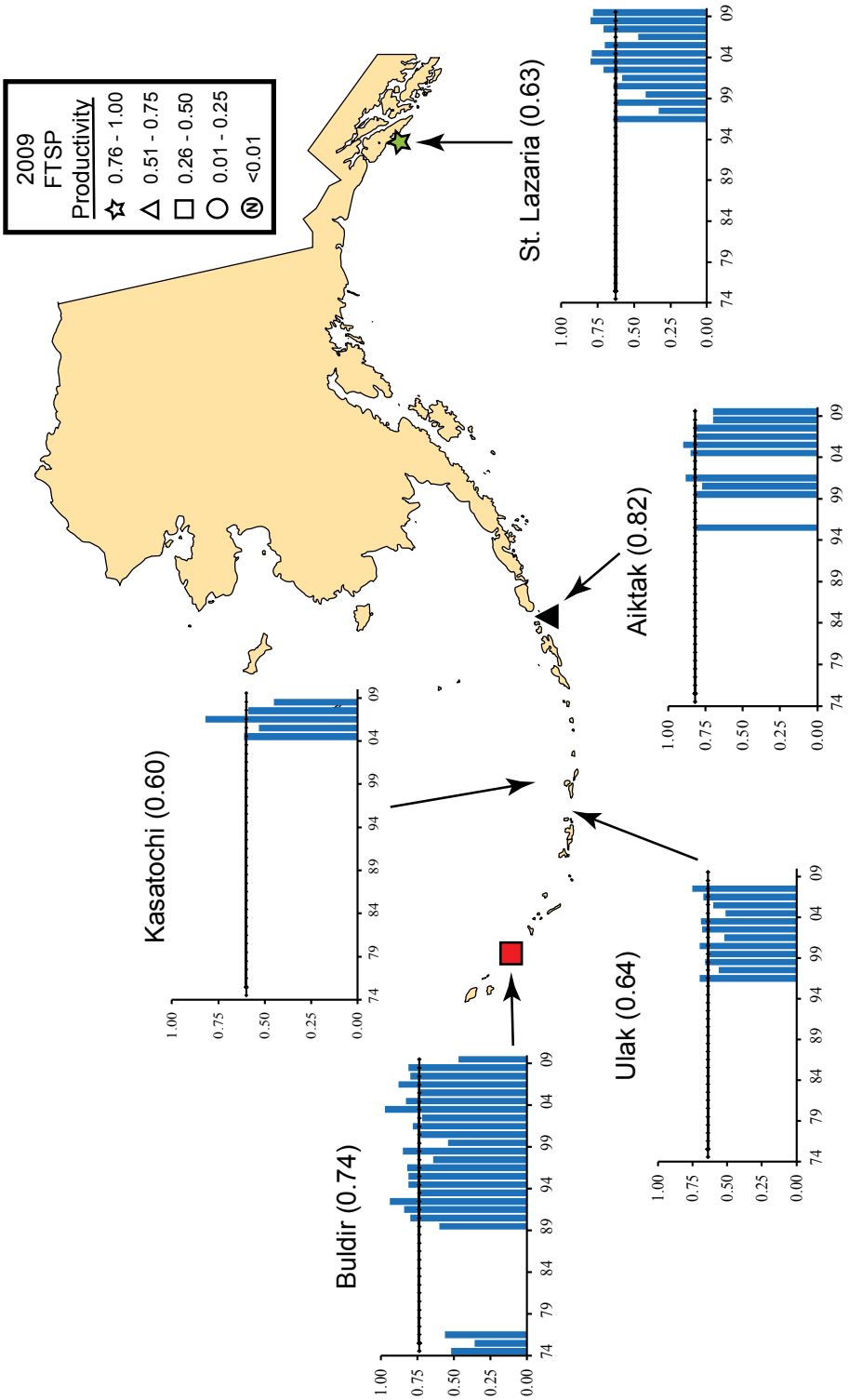


Figure 4. Productivity of fork-tailed storm-petrels (chicks fledged/egg) at Alaskan sites. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

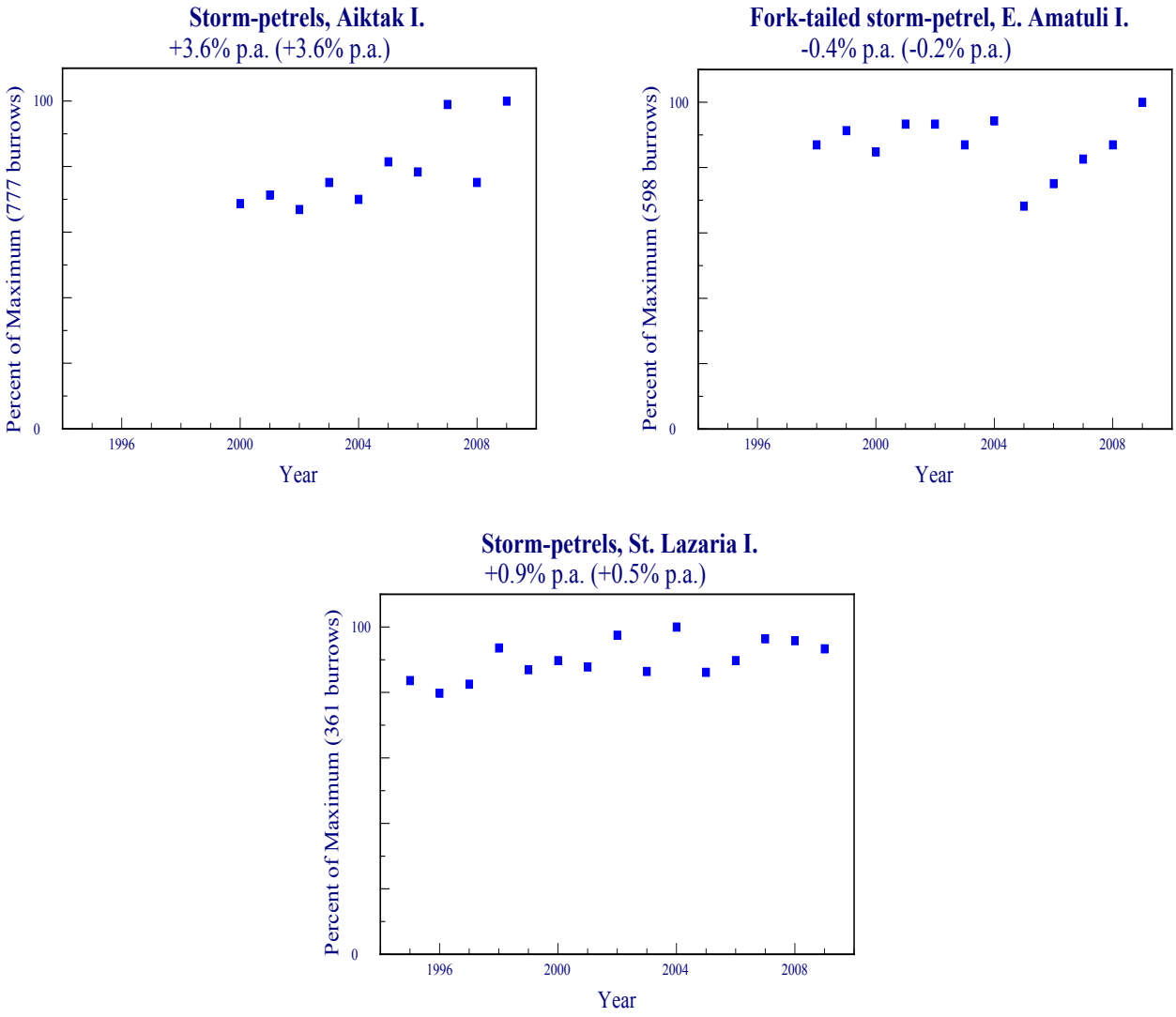


Figure 5. Trends in populations of storm-petrels at Alaskan sites. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (2000-2009, in parentheses).

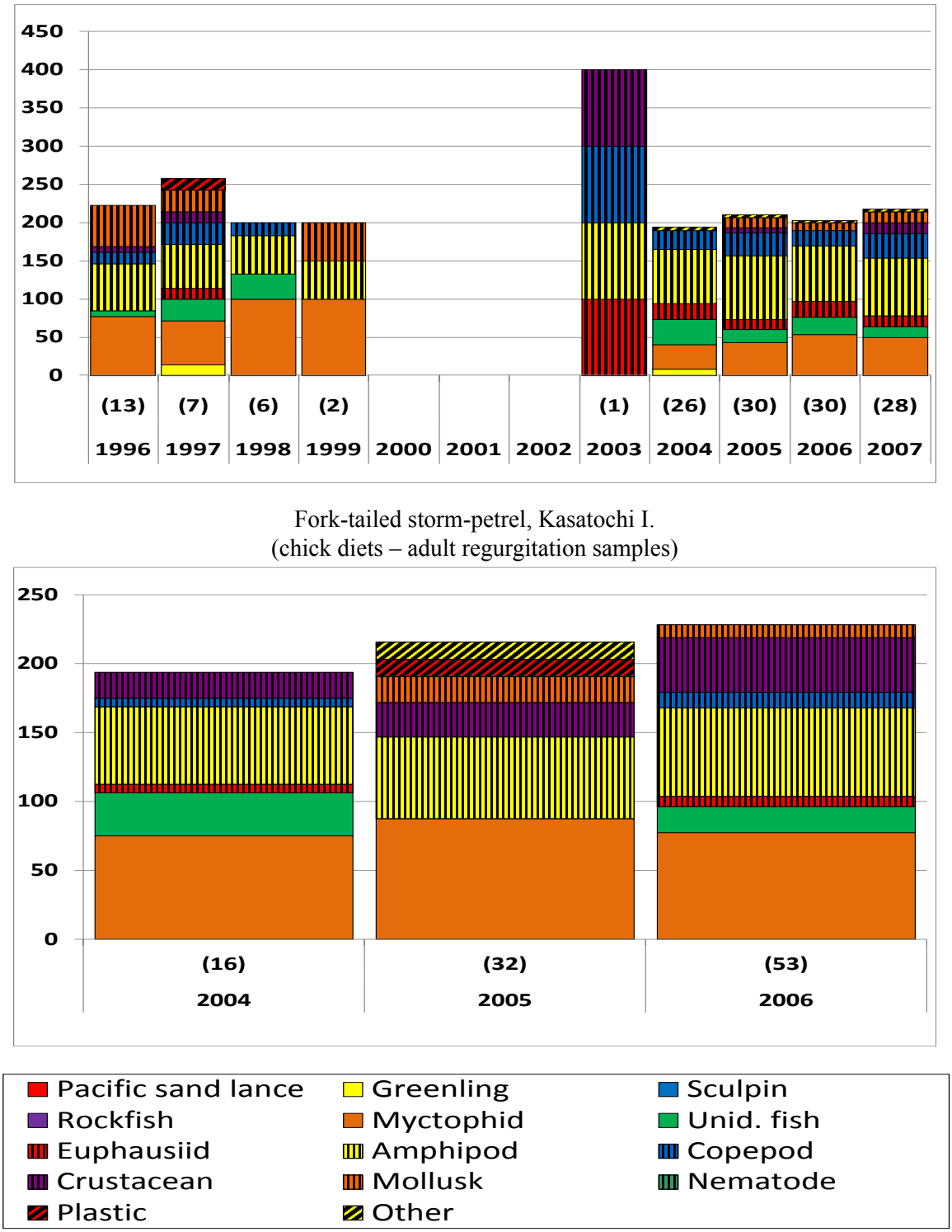
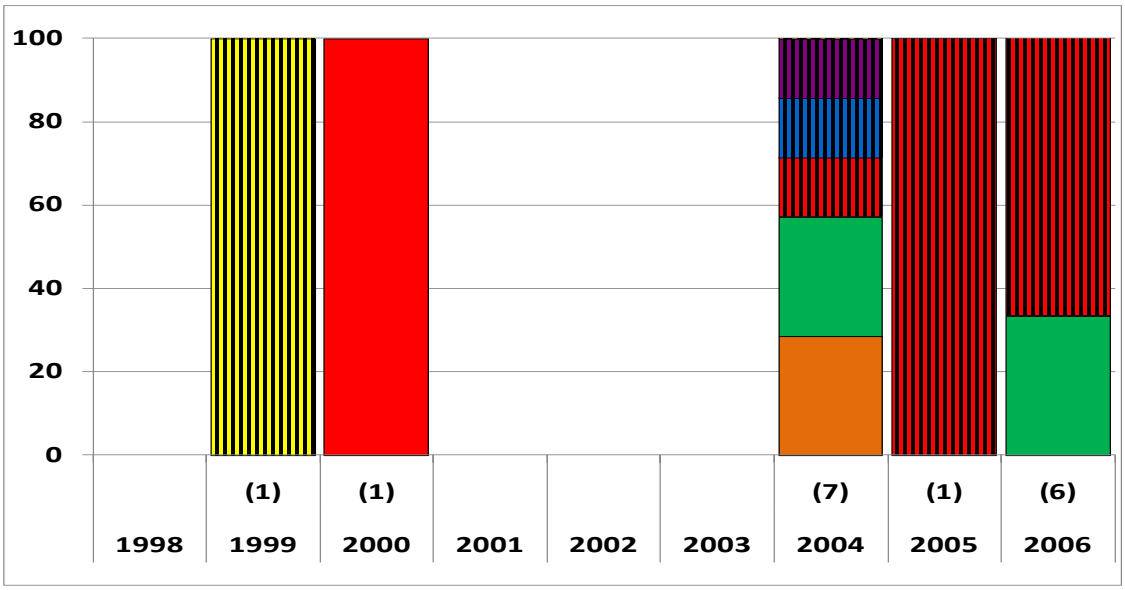
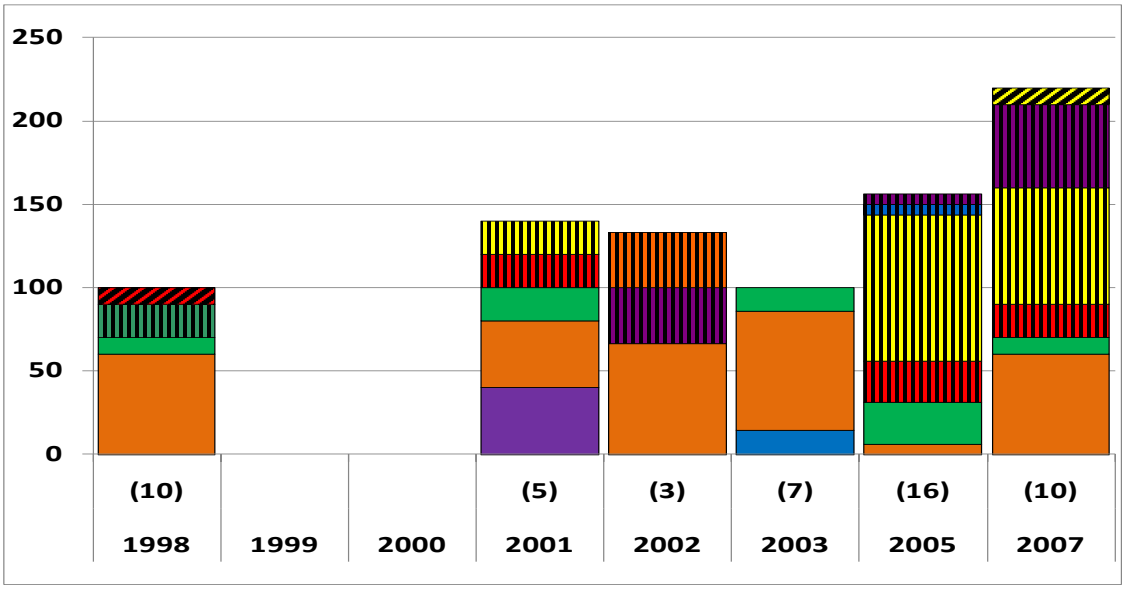


Figure 6. Diets of fork-tailed storm-petrels at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Fork-tailed storm-petrel, Aiktak I.
(chick diets – adult regurgitation samples)



Fork-tailed storm-petrel, St. Lazaria I.
(chick diets – adult regurgitation samples)



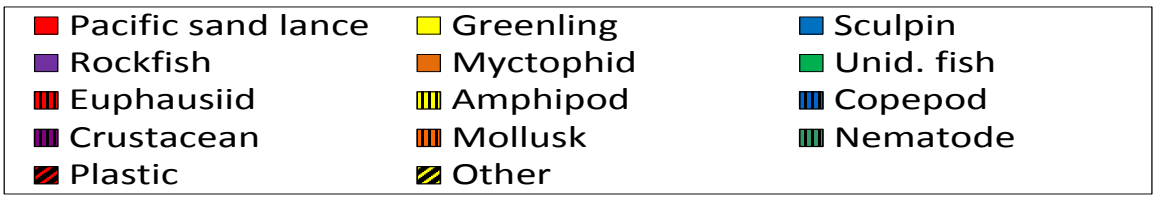


Figure 6 (continued). Diets of fork-tailed storm-petrels at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Leach's storm-petrel (*Oceanodroma leucorhoa*)

Breeding chronology.–The mean hatch date for Leach's storm-petrels was average at Aiktak and St. Lazaria islands in 2009 (Table 4, Figure 7).

Table 4. Hatching chronology of Leach's storm-petrels at Alaskan sites monitored in 2009.

Site	Median	Mean	Long-term Average	Reference
Aiktak I.	—	29 Jul (57)[a]	1 Aug[b] (12)[a]	Sapora et al. 2010
St. Lazaria I.	—	28 Jul (22)	31 Jul[b] (14)	L. Slater Unpubl. Data

[a]Sample size in parentheses represents the number of nest sites used to calculate the mean or median hatch date and the number of years used to calculate the long-term average. Current year not included in long-term average.

[b]Mean of annual means.

Productivity.–In 2009, productivity of Leach's storm-petrels was average at all monitored sites (Table 5, Figure 8).

Table 5. Reproductive performance of Leach's storm-petrels at Alaskan sites monitored in 2009.

Site	Chicks Fledged[a]/Egg	No. of Plots	Long-term Average	Reference
Buldir I.	0.84	5 (69)[b]	0.74 (23)[b]	Freeman et al. 2010
Aiktak I.	0.75	13 (99)	0.86 (9)	Sapora et al. 2010
St. Lazaria I.	0.59	8 (104)	0.57 (13)	L. Slater Unpubl. Data

[a]Fledged chick defined as being alive at last check in August or September.

[b]Sample size in parentheses represents the number of eggs used to calculate productivity and the number of years used to calculate the long-term average. Current year not used in long-term average.

Populations.–Fork-tailed and Leach's storm-petrel burrows were combined at most sites for population monitoring purposes. We found no trends for storm-petrel populations in either all years or between 2000 and 2009 at St. Lazaria Island. Storm-petrel numbers increased at Aiktak Island during both time periods (Figure 5).

Diet.–Diets of Leach's storm-petrels at Buldir Island contained mostly small fish, amphipods, and euphausiids (Figure 9). In a small sample from Aiktak Island, diet samples included predominantly fish and planktonic crustaceans. St. Lazaria Island samples consisted of a majority of larval fish and planktonic crustaceans.

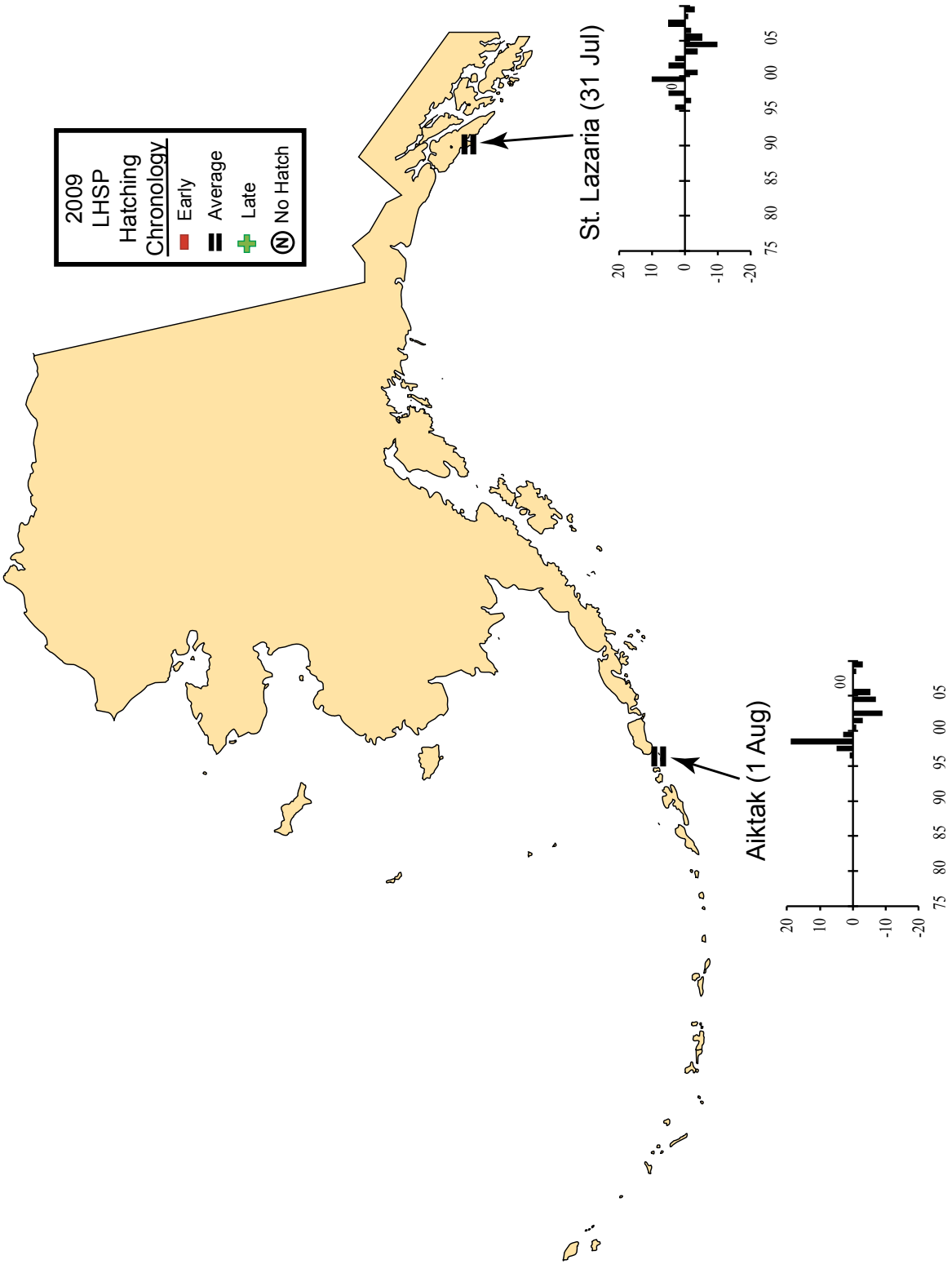


Figure 7. Hatching chronology of Leach's storm-petrels at Alaskan sites. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

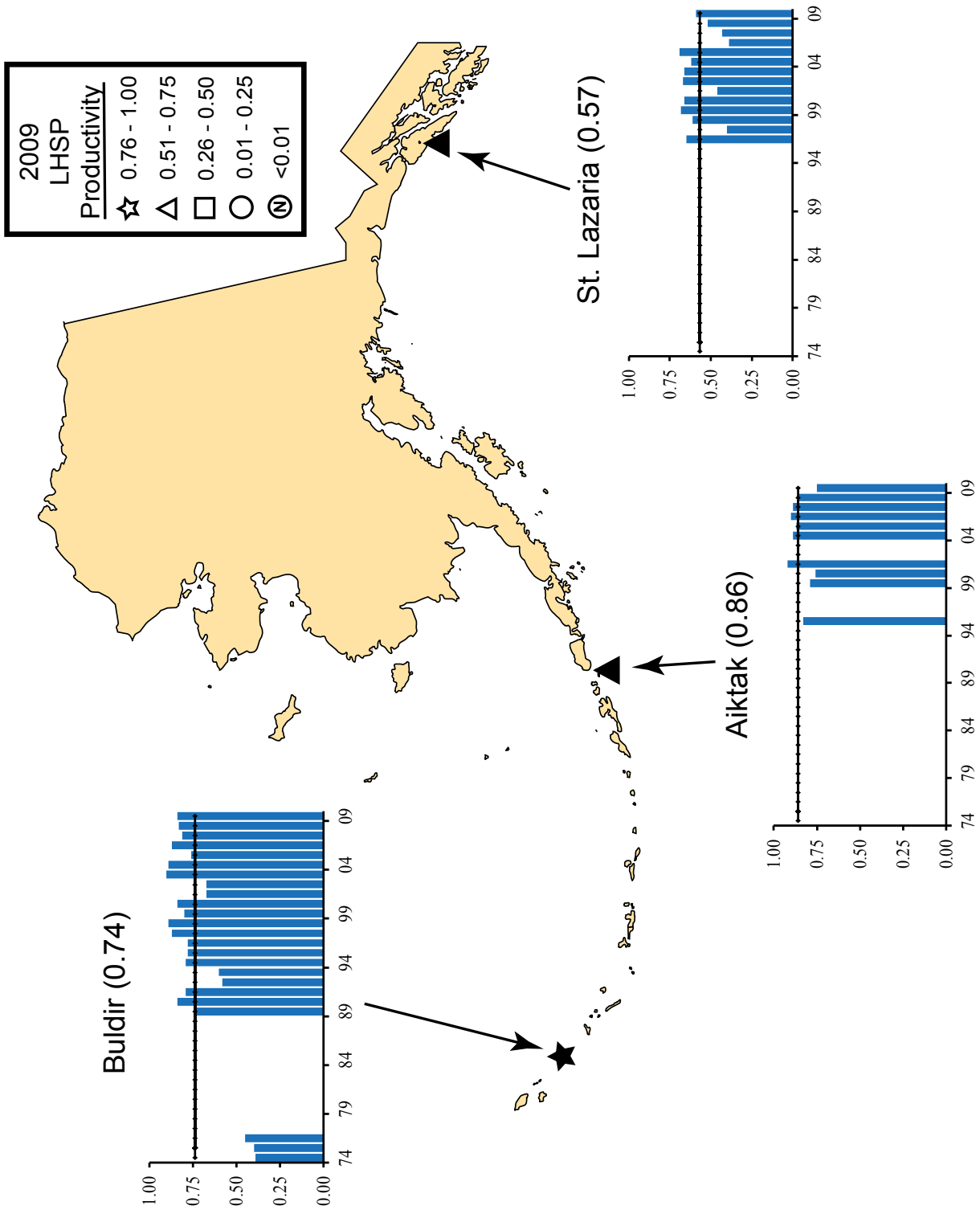


Figure 8. Productivity of Leach's storm-petrels (chicks fledged/egg) at Alaskan sites. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

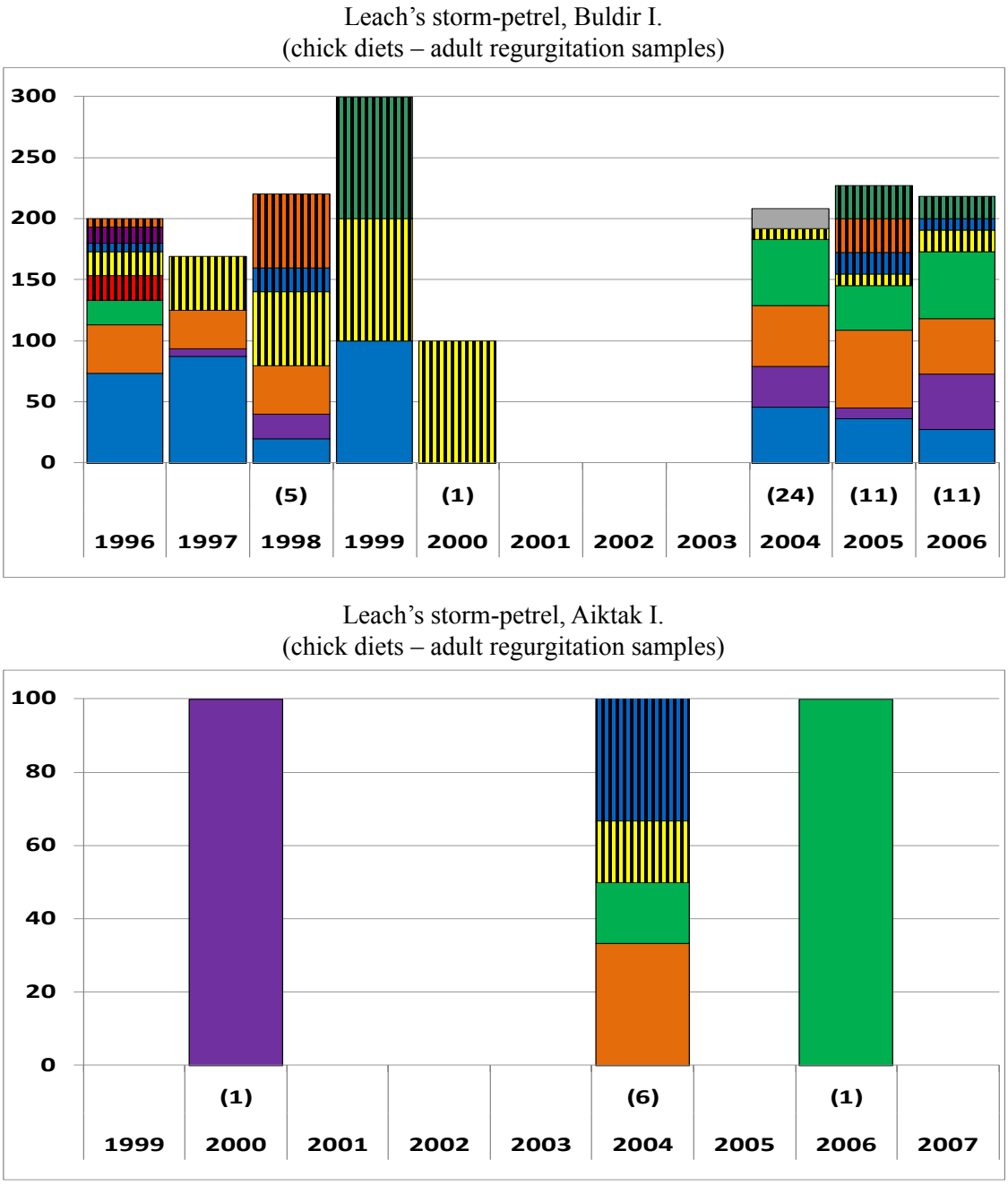


Figure 9. Diets of Leach's storm-petrels at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes, when available, are reported below each bar.

Leach's storm-petrel, St. Lazaria I.
(chick diets – adult regurgitation samples)

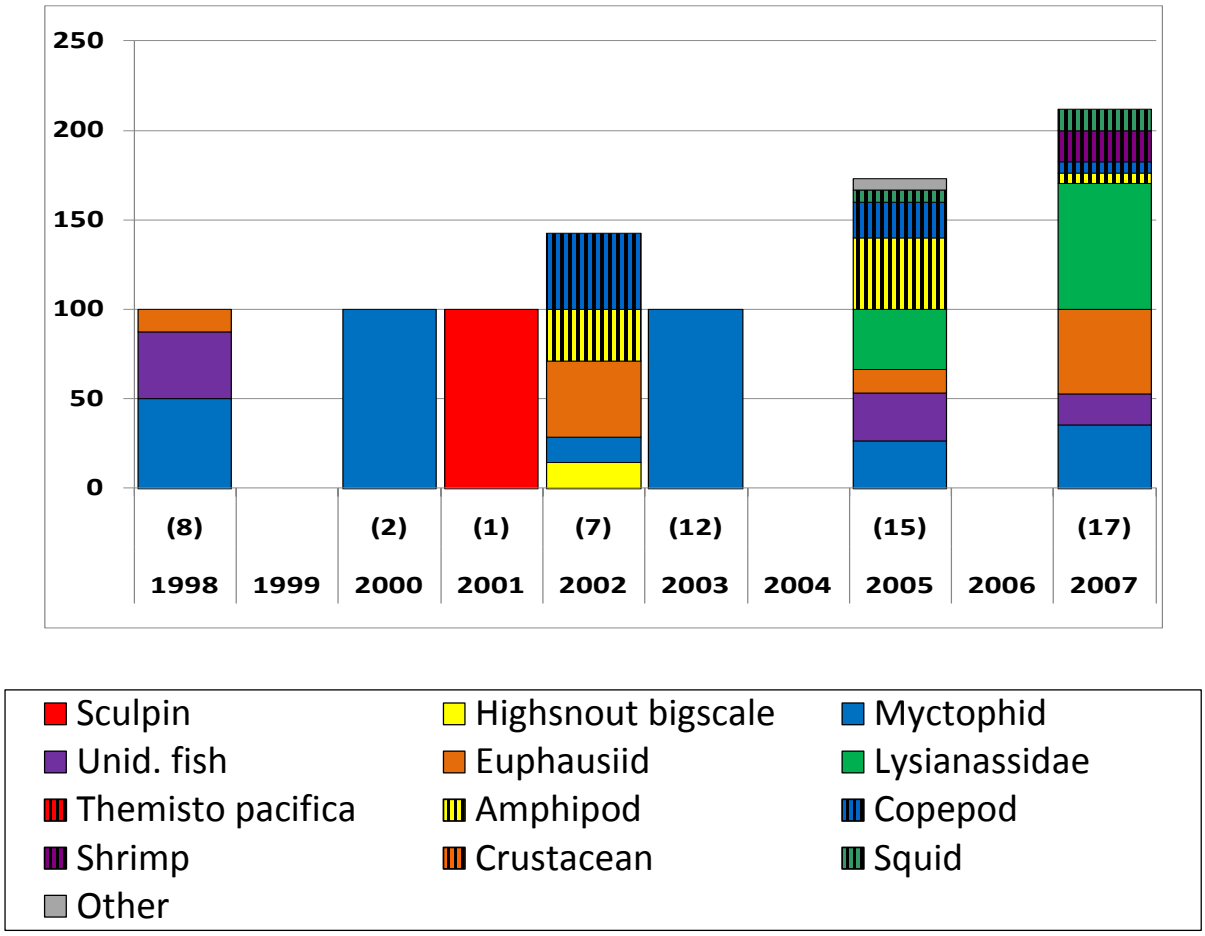


Figure 9 (continued). Diets of Leach's storm-petrels at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes, when available, are reported below each bar.

Red-faced cormorant (*Phalacrocorax urile*)

Breeding chronology.–Timing of hatching of red-faced cormorant eggs was average at St. Paul Island in 2009 (Table 6).

Table 6. Hatching chronology of red-faced cormorants at Alaskan sites monitored in 2009.

Site	Mean	Long-term Average	Reference
St. Paul I.	30 Jun (28)[a]	29 Jun[b] (20)[a]	McClintock et al. 2010

[a]Sample size in parentheses represents the number of nest sites used to calculate the mean or median hatch date and the number of years used to calculate the long-term average. Current year not included in long-term average.

[b]Mean of annual means.

Productivity.–In 2009, productivity of red-faced cormorants was below average at St. George Island, and average at Buldir and St. Paul islands (Table 7, Figure 10).

Table 7. Reproductive performance of red-faced cormorants at Alaskan sites monitored in 2009.

Site	Chicks Fledged/Nest	No. of Plots	Long-term Average	Reference
St. Paul I.	1.41	2 (44)[a]	1.21 (25)[a]	McClintock et al. 2010
St. George I.	0.93	3 (41)	1.29 (12)	Shannon et al. 2010
Buldir I.	1.67	N/A[b] (9)	1.64 (5)	Freeman et al. 2010

[a]Sample size in parentheses represents the number of nests used to calculate productivity and the number of years used to calculate the long-term average. Current year not used in long-term average.

[b]Not applicable or not reported.

Populations.–We found a negative trend in the number of cormorant nests (species combined) at Ulak Island between 2000 and 2009, as well as in all years (Figure 11). At Kasatochi and Aiktak islands, cormorants showed no trends over all years. Numbers declined at Kasatochi Island and remained stable at Aiktak Island between 2000 and 2009.

Diet.–No data.

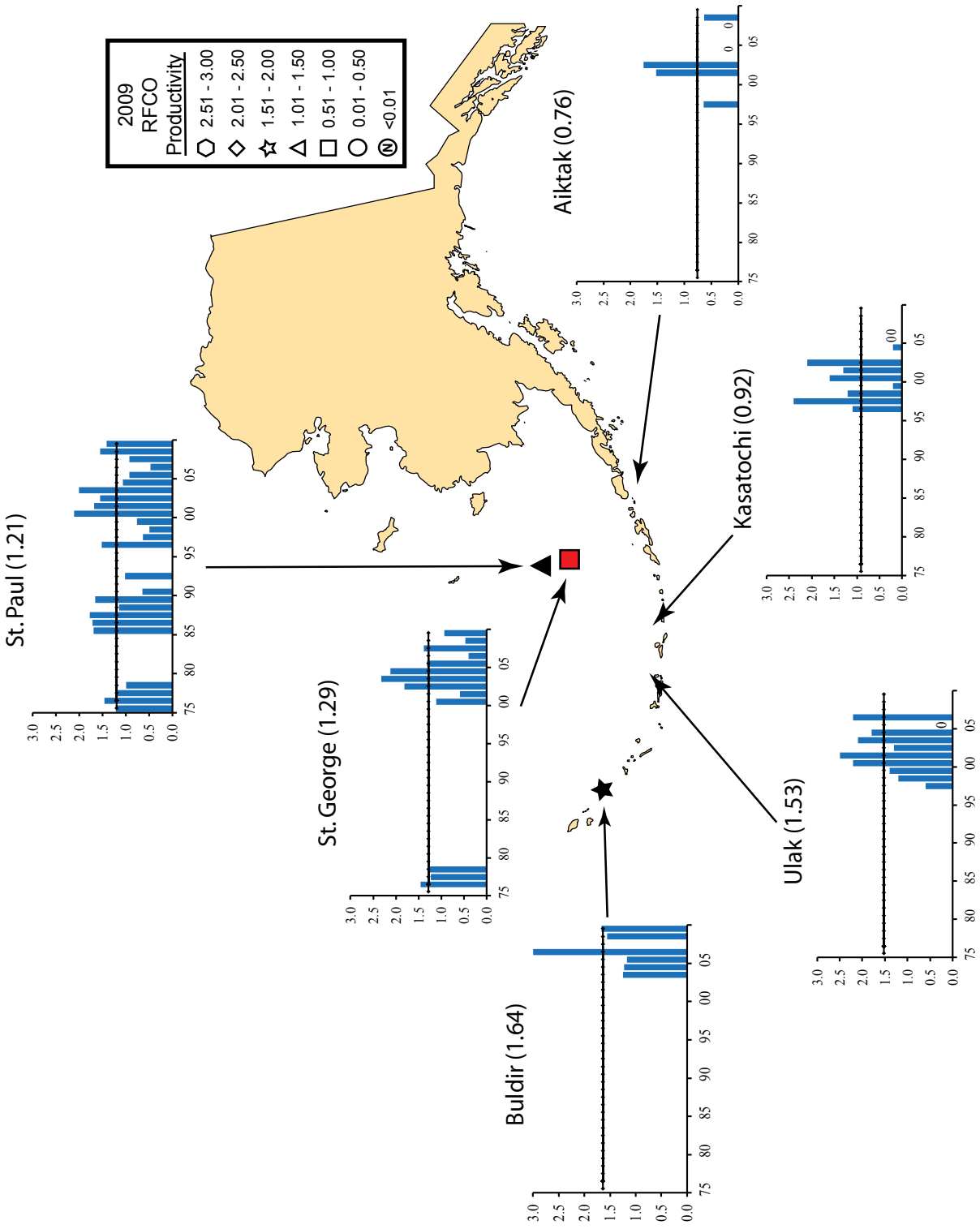


Figure 10. Productivity of red-faced cormorants (chicks fledged/nest) at Alaskan sites. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

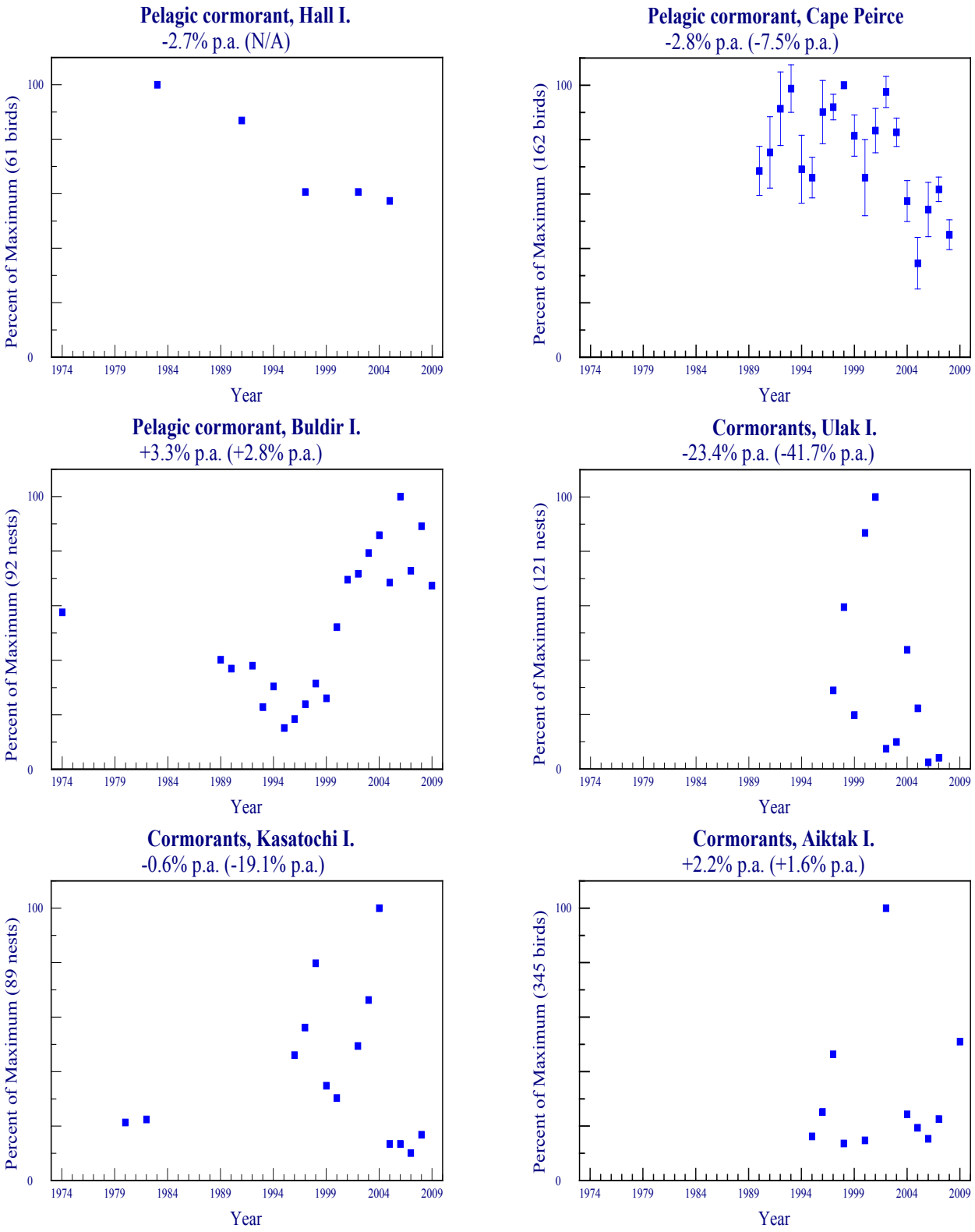
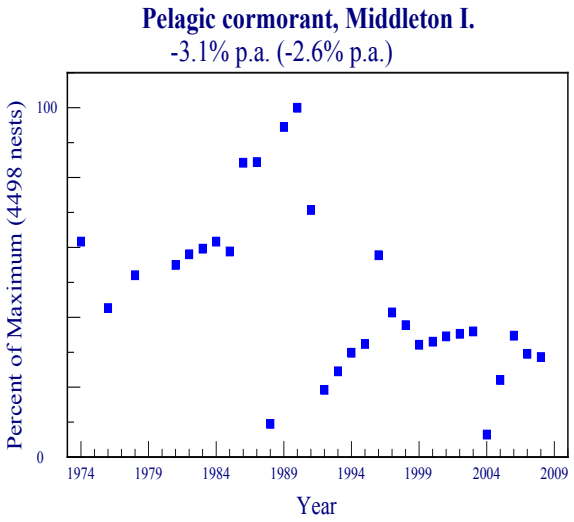


Figure 11. Trends in populations of cormorants at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (2000-2009, in parentheses). "N/A" indicates that insufficient data were available.



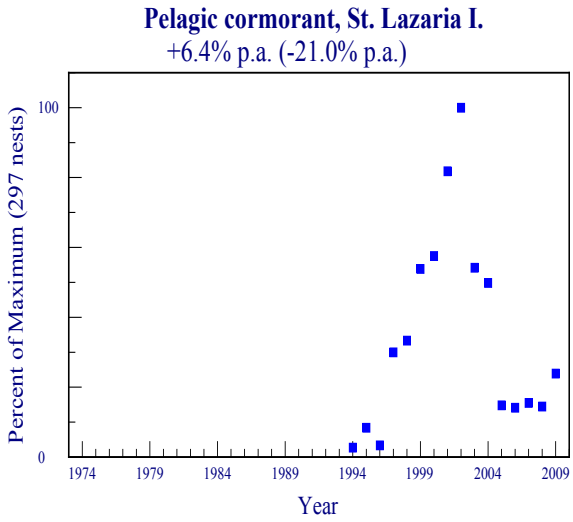


Figure 11 (continued). Trends in populations of cormorants at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (2000-2009, in parentheses). “N/A” indicates that insufficient data were available.

Pelagic cormorant (*Phalacrocorax pelagicus*)

Breeding chronology.–No data for 2009.

Productivity.–Pelagic cormorant productivity was below average at Cape Peirce and Aiktak Island, average at Round Island and above average at Buldir and St. Lazaria islands in 2009 (Table 8, Figure 12).

Table 8. Reproductive performance of pelagic cormorants at Alaskan sites monitored in 2009.

Site	Chicks Fledged/Nest	No. of Plots	Long-term Average	Reference
Cape Peirce	0.70	6 (37)[a]	1.22 (23)[a]	M. Swaim Unpubl. Data
Round I.	1.62	2 (37)	1.62 (8)	Okonek et al. 2010
Buldir I.	1.32	N/A[b] (62)	0.94 (19)	Freeman et al. 2010
Aiktak I.	0.00	N/A (26)	1.15 (8)	Sapora et al. 2010
St. Lazaria I.	1.00	N/A (71)	0.56 (15)	L. Slater Unpubl. Data

[a]Sample size in parentheses represents the number of nests used to calculate productivity and the number of years used to calculate the long-term average. Current year not used in long-term average.
[b]Not applicable or not reported.

Populations.–Pelagic cormorant populations were stable over all years at Hall Island but there were insufficient data from between 2000 and 2009 to assess recent trends there (Figure 11). This species showed no trend overall at Cape Peirce but declined there between 2000 and 2009. Numbers of nests increased in all years but remained stable between 2000 and 2009 at Buldir Island. Nest numbers were down overall but stable in recent years at Middleton Island, whereas an overall positive trend reversed at St. Lazaria between 2000 and 2009.

Diet.–Pelagic cormorants from St. Lazaria Island predominately ate fish, though invertebrates also comprised a significant portion of their diet (Figure 13).

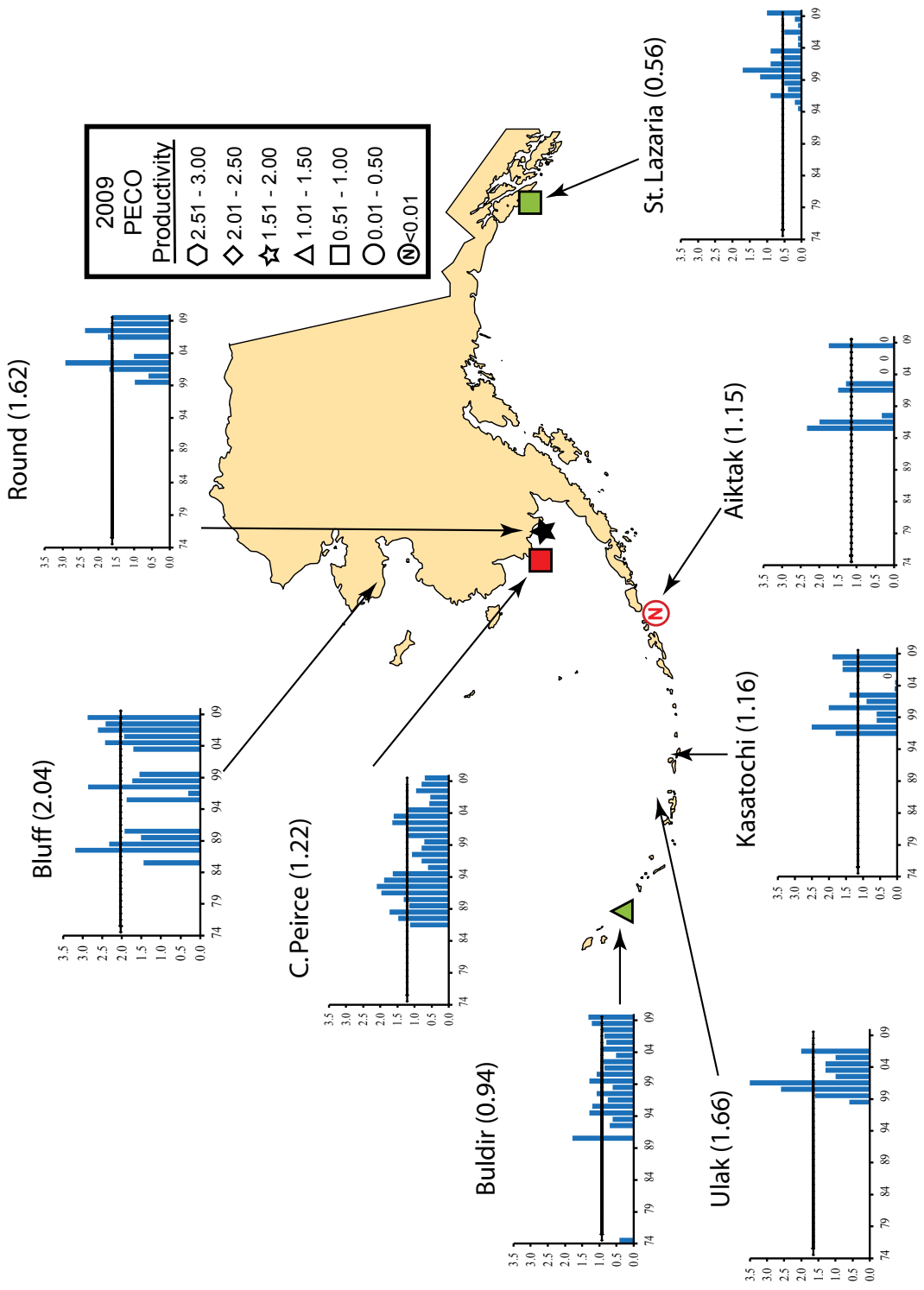


Figure 12. Productivity of pelagic cormorants (chicks fledged/nest) at Alaskan sites. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

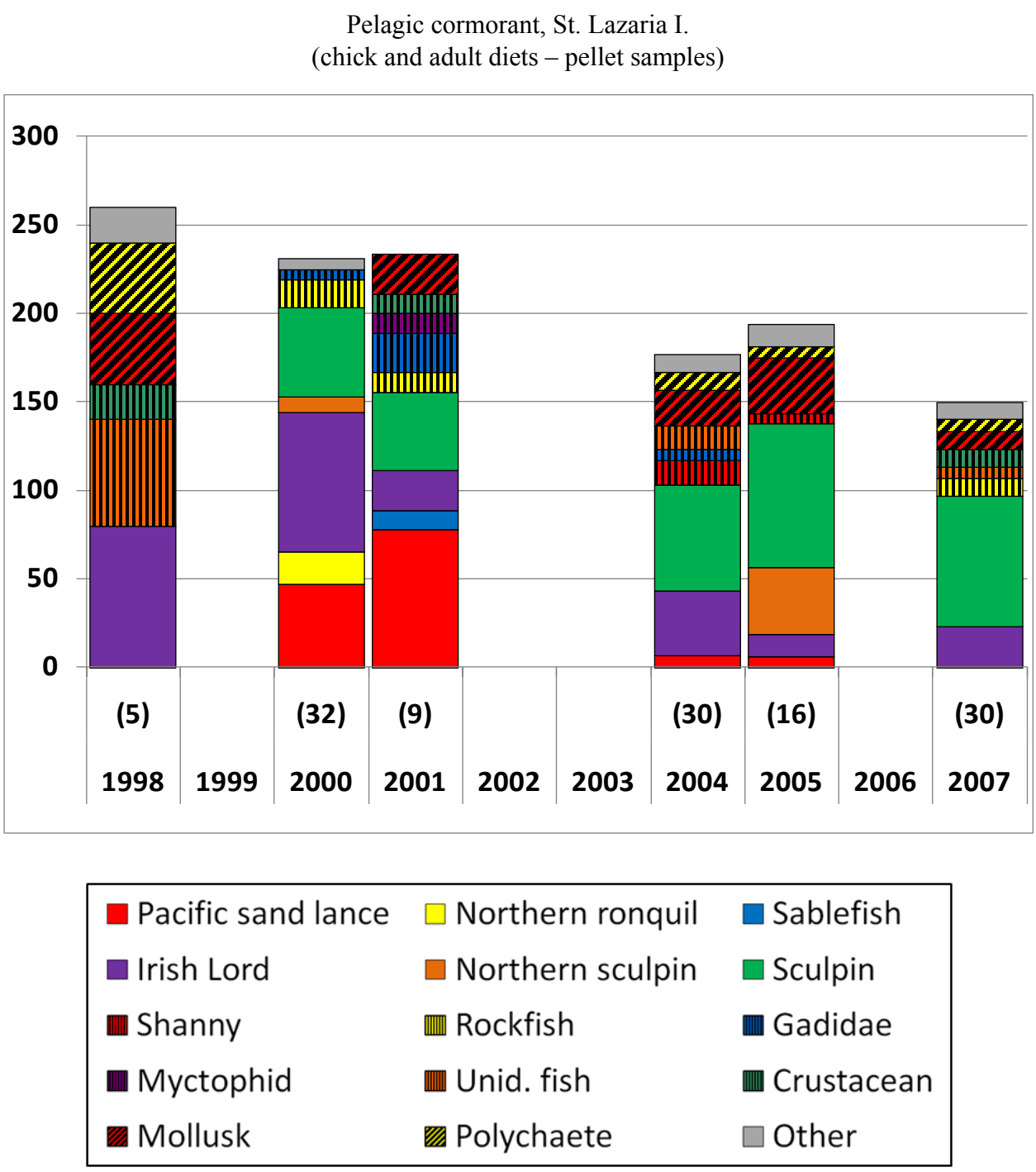


Figure 13. Diets of pelagic cormorants at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Black-legged kittiwake (*Rissa tridactyla*)

Breeding chronology.–In 2009, black-legged kittiwake hatching was early at three sites and late at Buldir Island (Table 9, Figure 14).

Table 9. Hatching chronology of black-legged kittiwakes at Alaskan sites monitored in 2009.

Site	Median	Mean	Long-term Average	Reference
St. Paul I.	—	9 Jul (24)[a]	19 Jul[b] (25)[a]	McClintock et al. 2010
St. George I.	—	4 Jul (13)	18 Jul[b] (27)	Shannon et al. 2010
Buldir I.	—	18 Jul (57)	7 Jul[b] (21)	Freeman et al. 2010
Chowiet I.	—	12 Jul (103)	18 Jul[b] (14)	Andersen et al. 2010
Homer	10 Jul (20)	15 Jul (20)	N/A[c]	M. Kuter Unpubl. Data

[a]Sample size in parentheses represents the number of nest sites used to calculate the mean or median hatch date and the number of years used to calculate the long-term average. Current year not included in long-term average.
[b]Mean of annual means.
[c]Not applicable or not reported.

Productivity.–Productivity of black-legged kittiwakes was below average at six of the monitored colonies in 2009 and above average at two sites (Table 10, Figure 15).

Table 10. Reproductive performance of black-legged kittiwakes at Alaskan sites monitored in 2009.

Site	Chicks Fledged[a]/Nest	No. of Plots	Long-term Average	Reference
C. Lisburne	0.10[b]	2 (284)[c]	0.67 (27)[c]	D. Roseneau Unpubl. Data
St. Paul I.	0.02	16 (422)	0.29 (29)	McClintock et al. 2010
St. George I.	0.04	6 (169)	0.23 (33)	Shannon et al. 2010
Cape Peirce	0.25	13 (227)	0.18 (26)	M. Swaim Unpubl. Data
Round I.	0.00	2 (51)	0.23 (10)	Okonek et al. 2010
Buldir I.	0.20	7 (217)	0.15 (21)	Freeman et al. 2010
Chowiet I.	0.01	10 (292)	0.19 (17)	Andersen et al. 2010
E. Amatuli I.	0.01	11 (291)	0.39 (22)	A. Kettle Unpubl. Data
Homer	0.22	N/A[d]	N/A[d]	M. Kuter Unpubl. Data

[a]Total chicks fledged/Total nests.
[b]Short visit.
[c]Sample size in parentheses represents the number of nests used to calculate productivity and the number of years used to calculate the long-term average. Current year not used in long-term average.
[d]Not applicable or not reported.

Populations.–Black-legged kittiwake populations increased both overall and between 2000 and 2009 at Cape Lisburne, and remained stable during both time periods at Bluff (Figure 16). Hall Island kittiwakes exhibited a declining trend over all years but there were insufficient

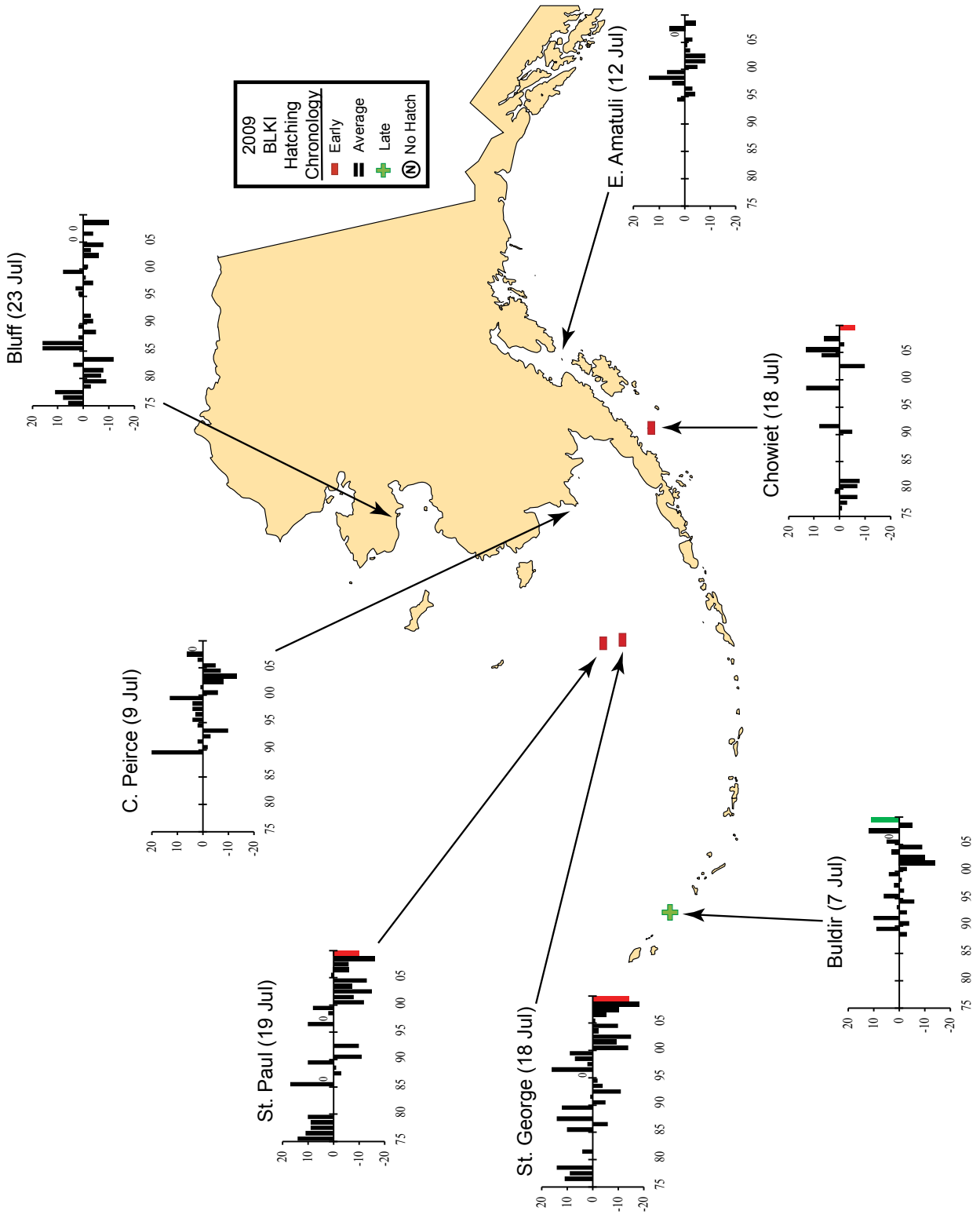


Figure 14. Hatching chronology of black-legged kittiwakes at Alaskan sites. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

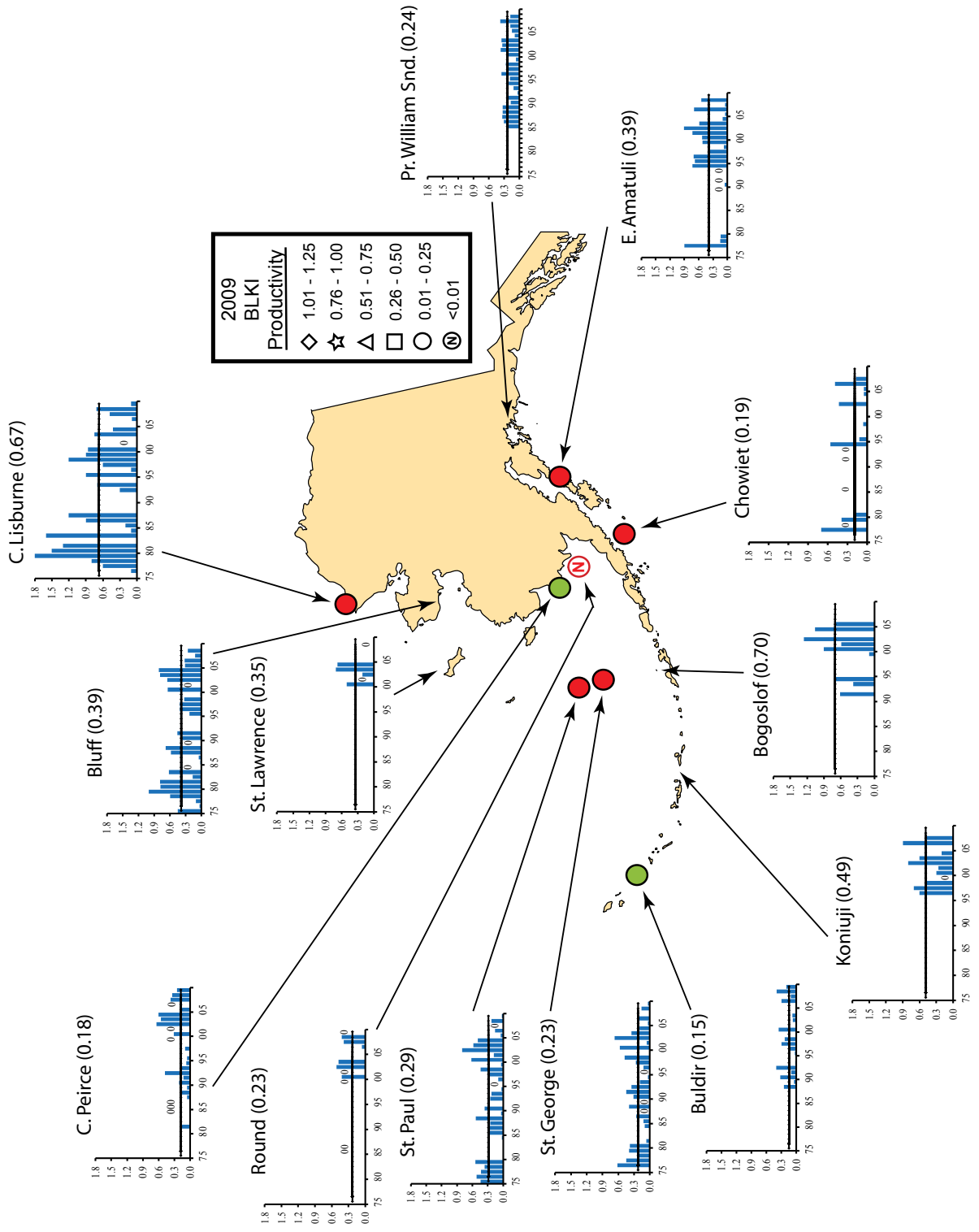


Figure 15. Productivity of black-legged kittiwakes (chicks fledged/nest) at Alaskan sites. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

data to assess trends between 2000 and 2009. Kittiwake numbers remained stable over all years, with increasing populations between 2000 and 2009 at St. Paul Island. No trends were evident at St. George Island in either time period. Populations declined during both time periods at Cape Peirce but remained stable at Round Island. Kittiwakes increased overall at Buldir Island but showed a decline there between 2000 and 2009. No trends were indicated for kittiwakes at Koniuji or Chowiet islands in all years but numbers have increased at both locations recently. Kittiwake numbers were stable over all years, and between 2000 and 2009 as well, in Prince William Sound, whereas populations declined during both time periods at Middleton Island.

Diet.–In a small sample collected from Cape Lisburne, black-legged kittiwakes predominately ate small fish prey, including sand lance, gadids, and cod (Figure 17). Diets from St. Paul Island included primarily myctophids, pollock, sand lance, squid, and a variety of other small fish and invertebrates. Black-legged kittiwakes from St. George Island ate primarily myctophids, pollock, sand lance, euphausiids, and other larval fish and small invertebrates. Kittiwakes from the Semidi Islands ate predominately capelin and sand lance. Buldir Island samples were predominately myctophids, greenling, euphausiids, and amphipods, with a variety of other larval fish and small invertebrates as lesser prey items. Diet samples from Koniuji Island included primarily myctophids with lesser occurrences of greenling and euphausiids. Bogoslof Island adults and chicks ate predominately myctophids along with lesser amounts of other larval fish and small crustaceans. Prince William Sound kittiwakes ate primarily herring and sand lance. Barren Islands diet samples included capelin and sand lance.

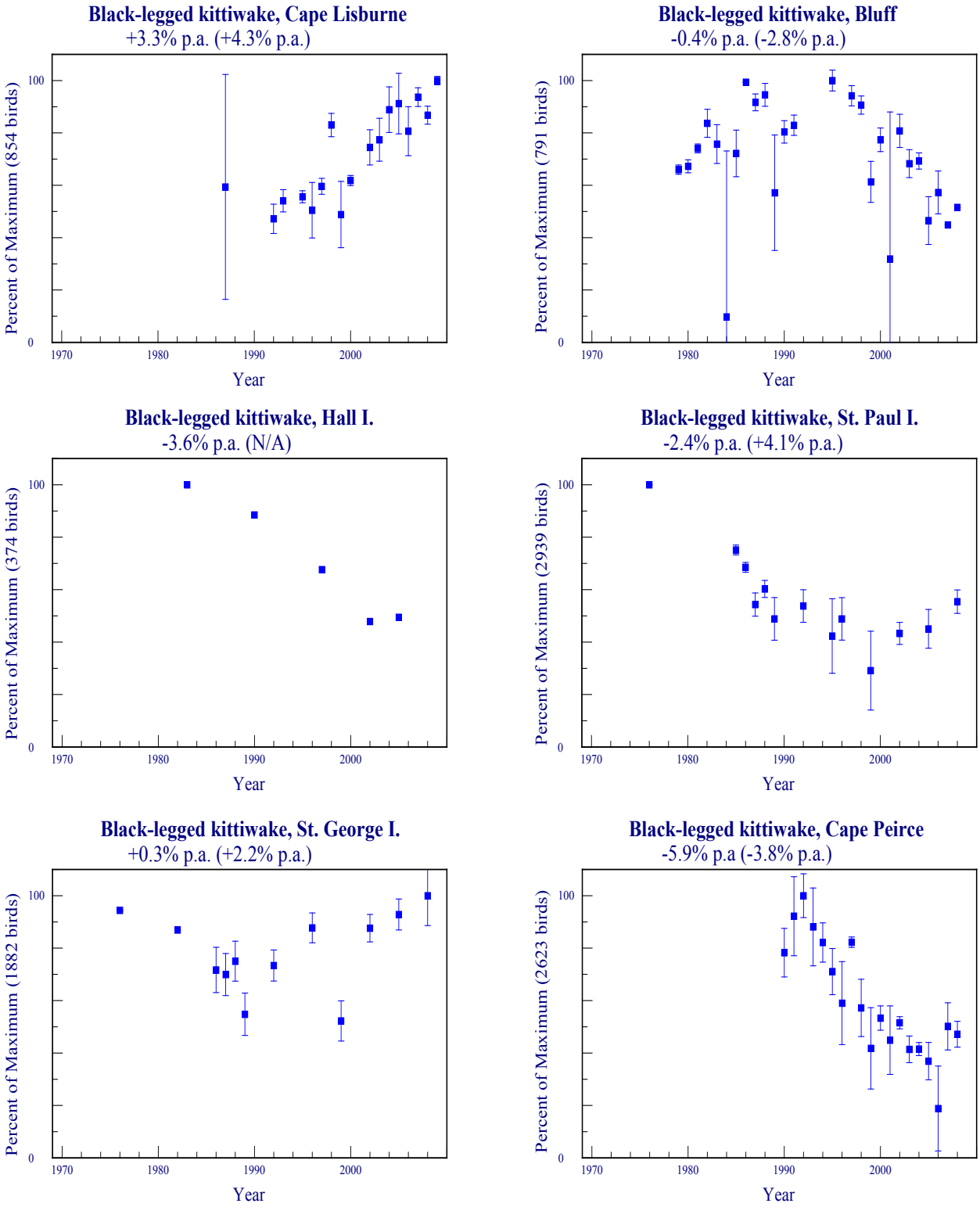


Figure 16. Trends in populations of black-legged kittiwakes at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (2000-2009, in parentheses). "N/A" indicates that insufficient data were available.

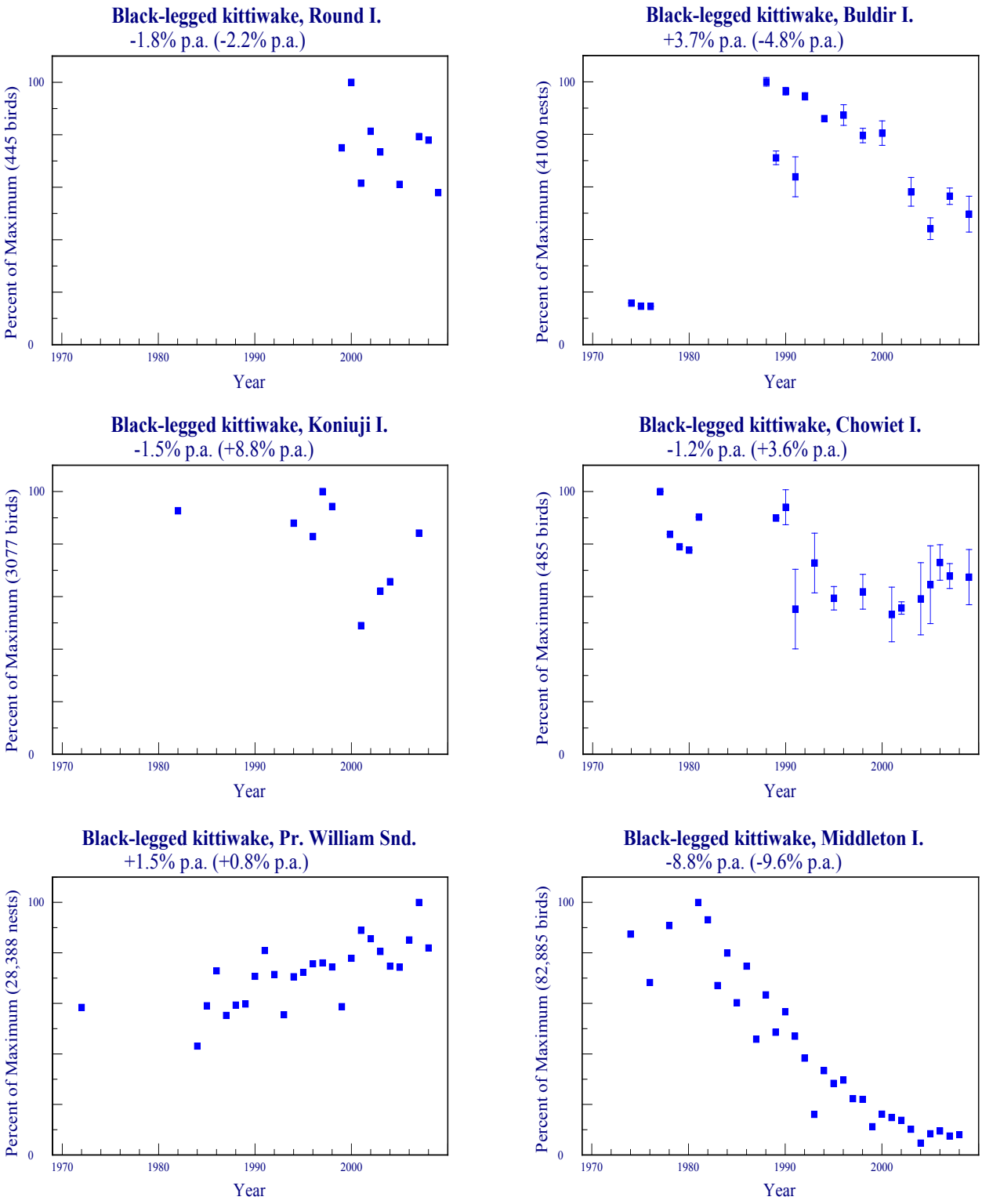
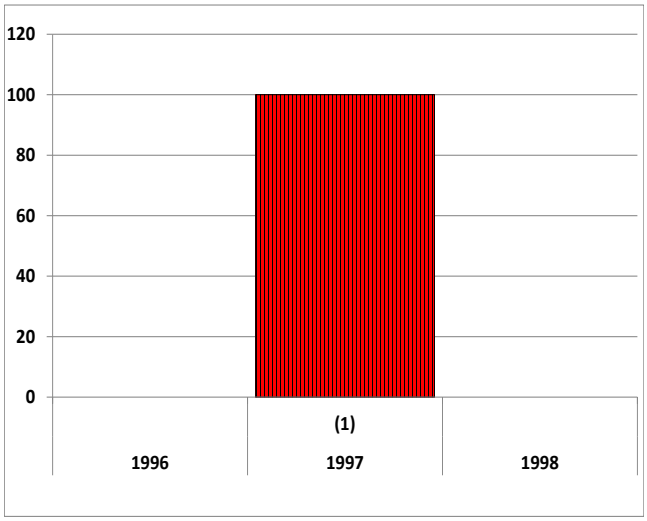
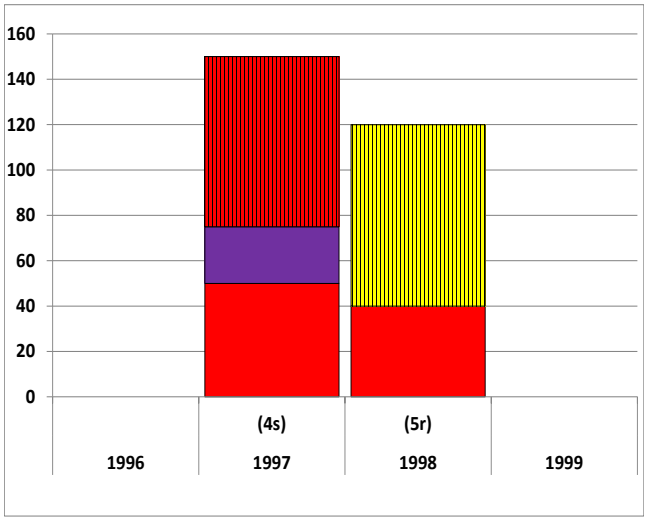


Figure 16 (continued). Trends in populations of black-legged kittiwakes at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (2000-2009, in parentheses). "N/A" indicates that insufficient data were available.

Black-legged kittiwake, Cape Lisburne
(adult diets – stomach samples)



Black-legged kittiwake, Cape Lisburne
(chick diets – regurgitation and stomach samples)



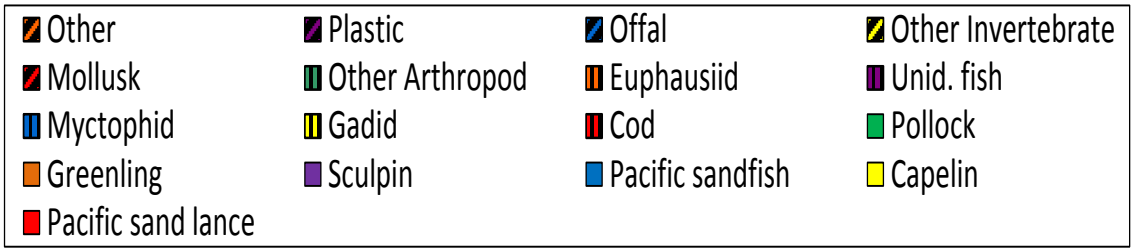
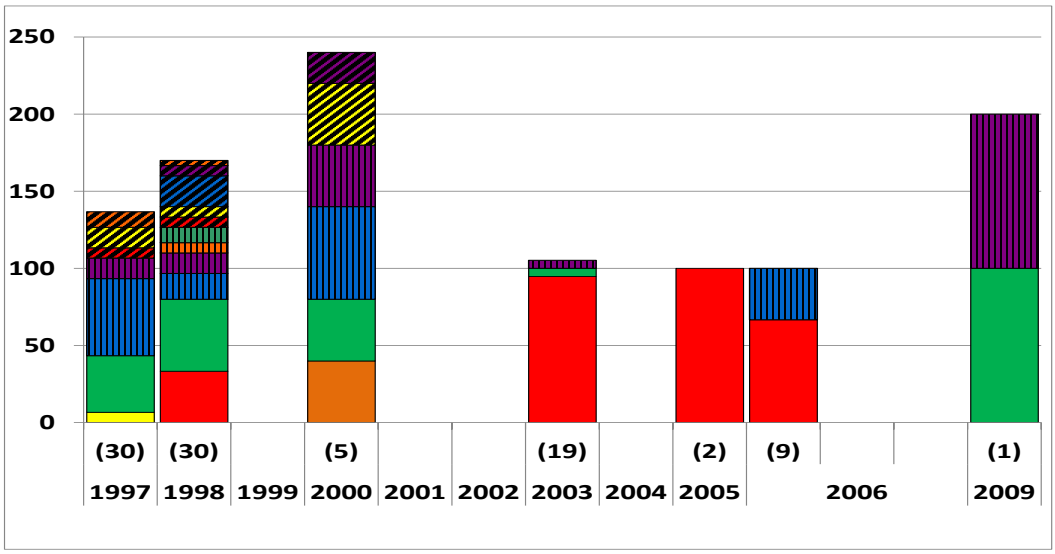
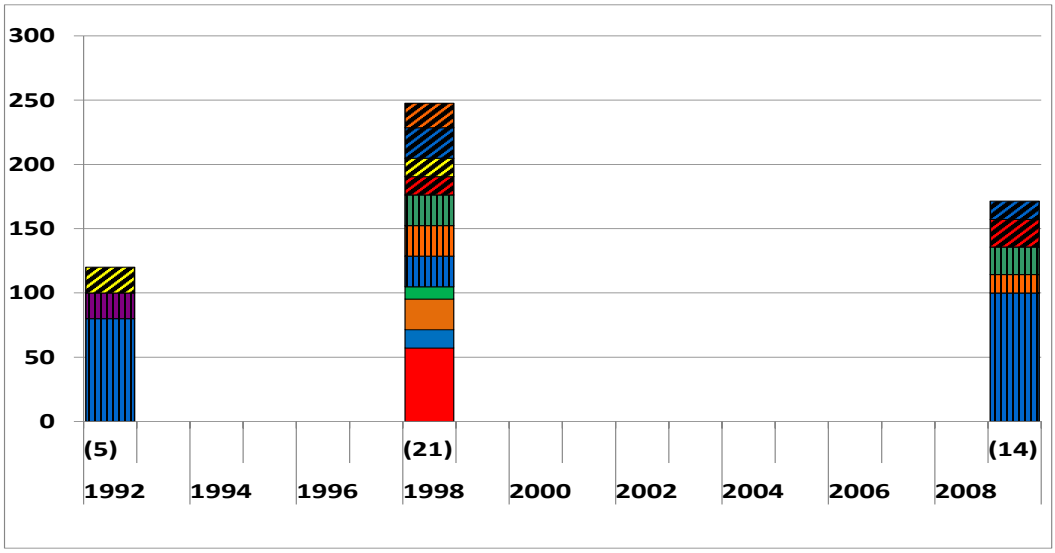


Figure 17. Diets of black-legged kittiwakes at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Black-legged kittiwake, St. Paul I.
(chick diets – regurgitation samples)



Black-legged kittiwake, St. George I.
(chick diets – regurgitation samples)



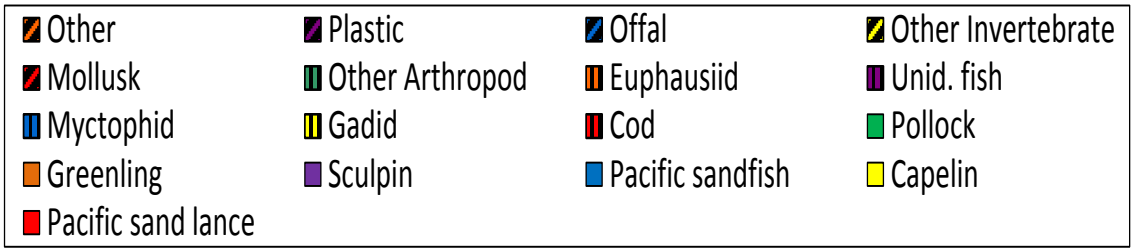


Figure 17 (continued). Diets of black-legged kittiwakes at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

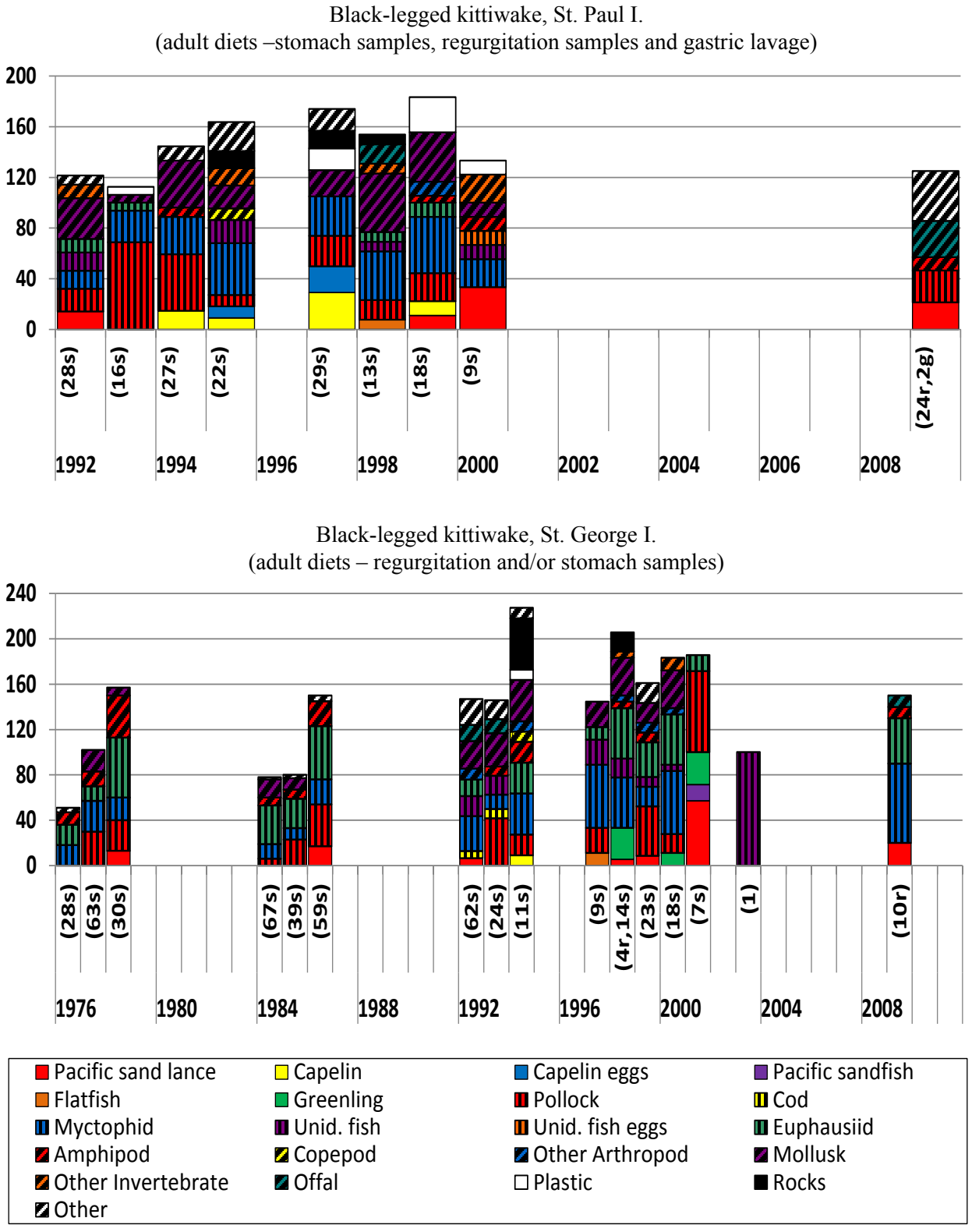


Figure 17 (continued). Diets of black-legged kittiwakes at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

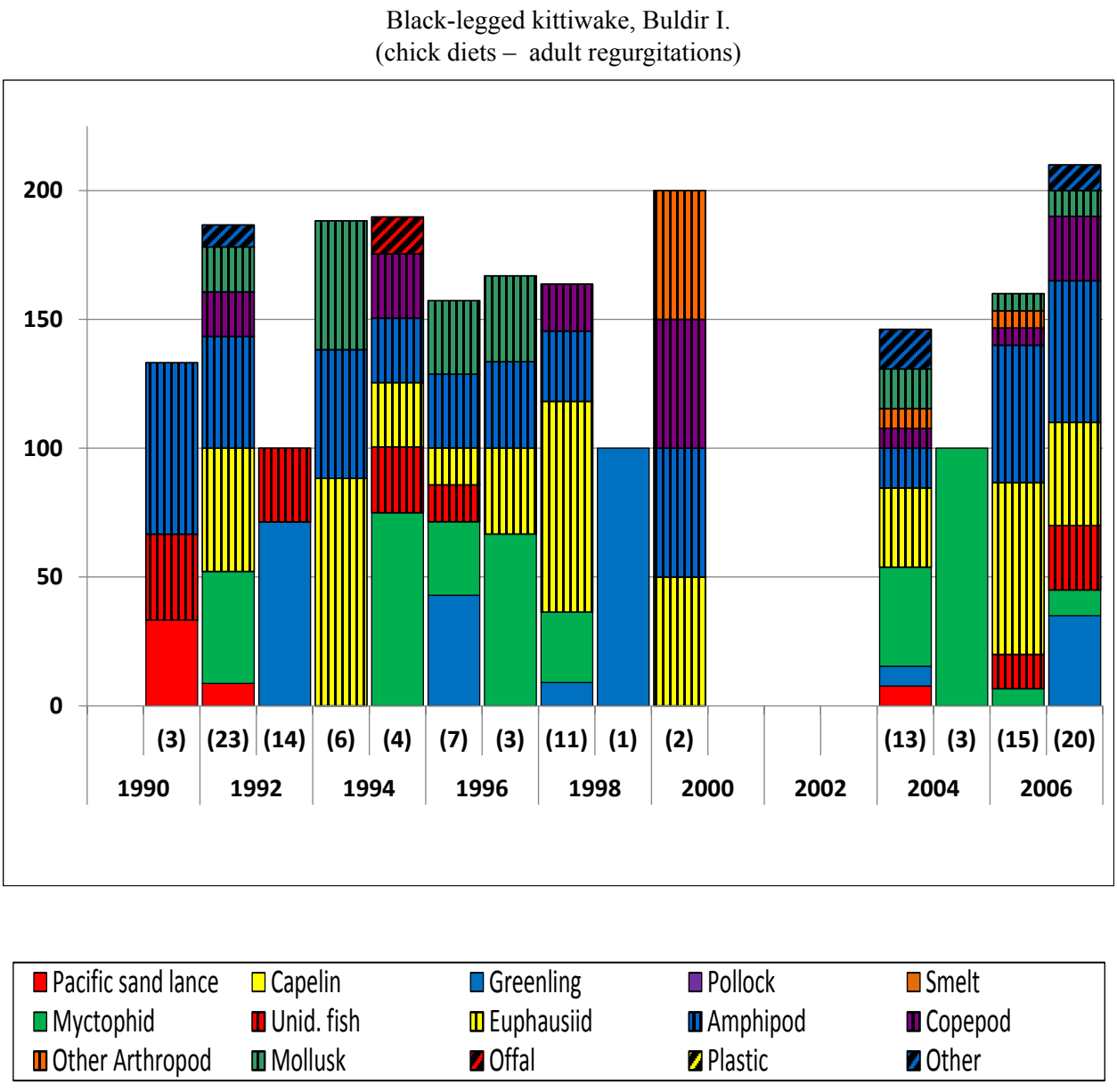
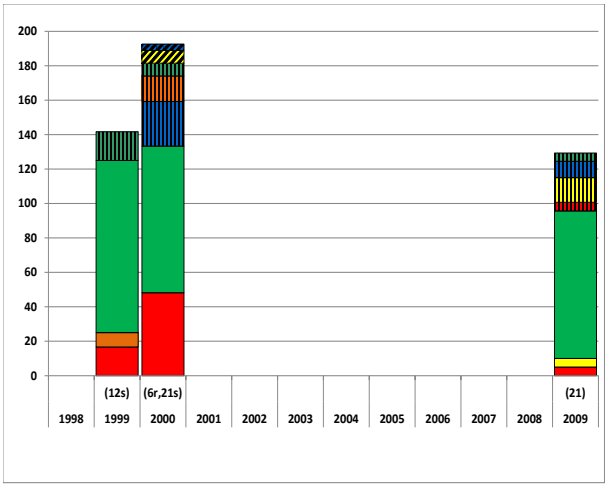
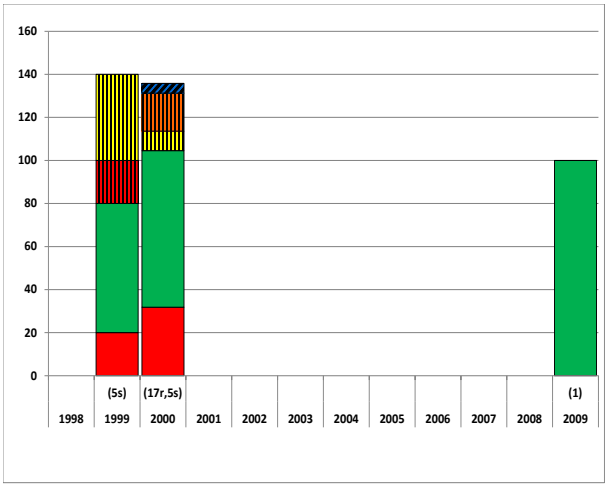


Figure 17 (continued). Diets of black-legged kittiwakes at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

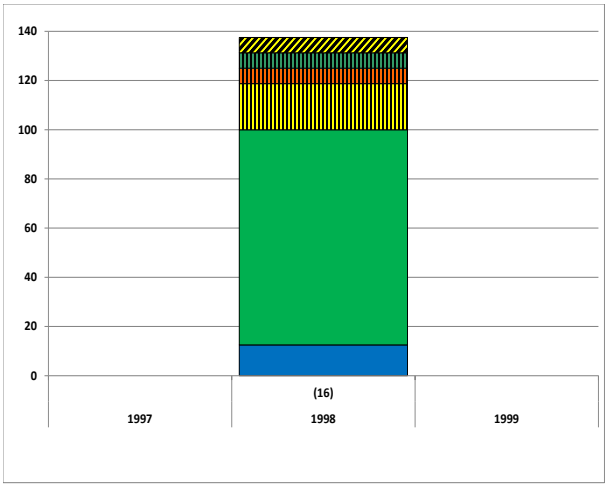
Black-legged kittiwake, Bogoslof I.
(adult diets – regurgitation and/or stomach samples)



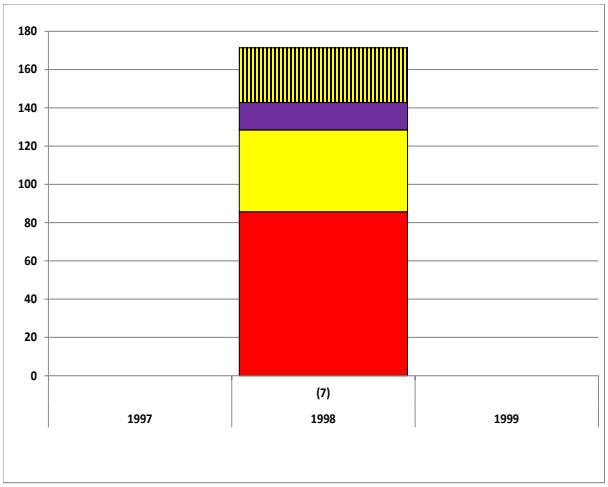
Black-legged kittiwake, Bogoslof I.
(chick diets – regurgitation and/or stomach samples)



Black-legged kittiwake, Koniuji I.
(adult diets – stomach samples)



Black-legged kittiwake, Semidi Is.
(chick diets – regurgitation samples)



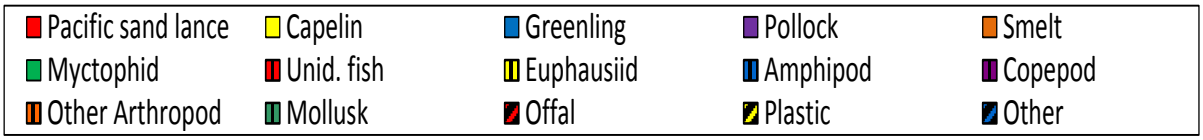
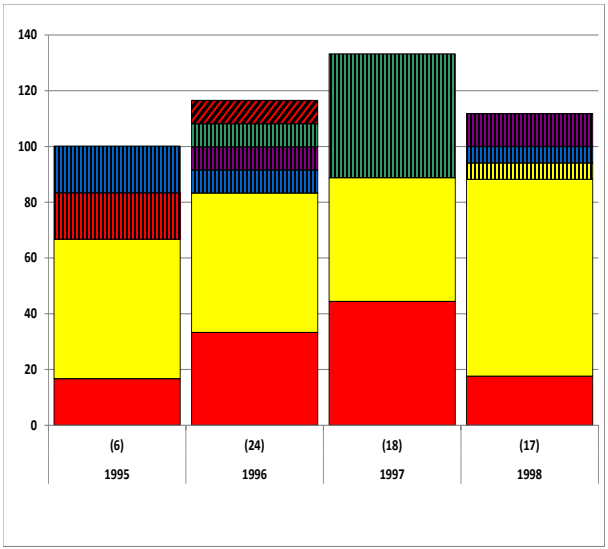
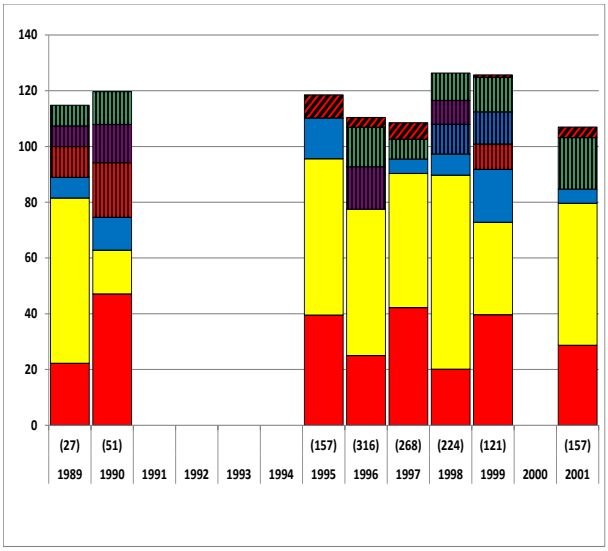


Figure 17 (continued). Diets of black-legged kittiwakes at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

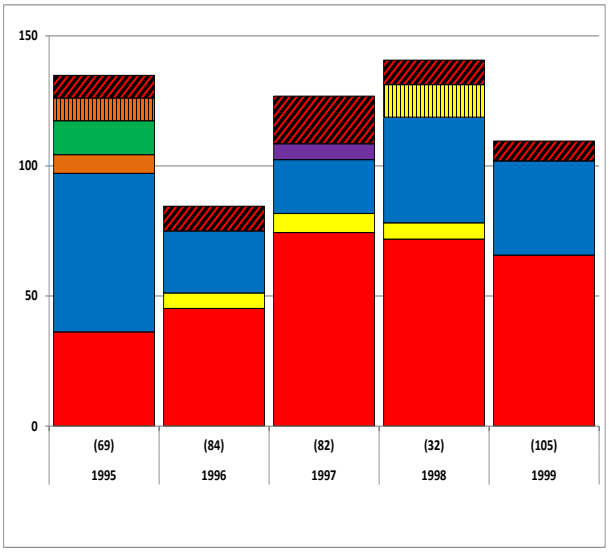
Black-legged kittiwake, Prince William Sound
(adult diets – regurgitation samples)



Black-legged kittiwake, Prince William Sound
(chick diets – regurgitation samples)



Black-legged kittiwake, Barren Is.
(chick diets – regurgitation samples)



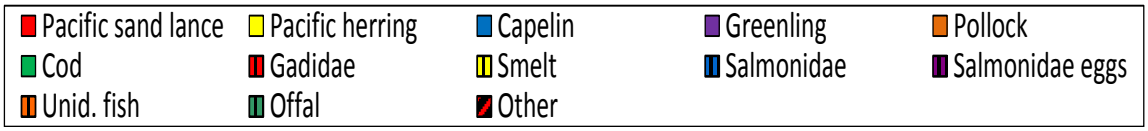


Figure 17 (continued). Diets of black-legged kittiwakes at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Red-legged kittiwake (*Rissa brevirostris*)

Breeding chronology.–Hatch date was early at the Pribilof Islands and late at Buldir Island in 2009 (Table 11, Figure 18).

Table 11. Hatching chronology of red-legged kittiwakes at Alaskan sites monitored in 2009.

Site	Mean	Long-term Average	Reference
St. Paul I.	8 Jul (5)[a]	20 Jul[b] (24)[a]	McClintock et al. 2010
St. George I.	5 Jul (107)	17 Jul[b] (28)	Shannon et al. 2010
Buldir I.	25 Jul (9)	11 Jul[b] (19)	Freeman et al. 2010

[a]Sample size in parentheses represents the number of nest sites used to calculate the mean hatch date and the number of years used to calculate the long-term average. Current year not included in long-term average.

[b]Mean of annual means.

Productivity.–In 2009, red-legged kittiwakes experienced low productivity at St. George Island, average success at St. Paul Island and above average productivity at Buldir Island (Table 12, Figure 19).

Table 12. Reproductive performance of red-legged kittiwakes at Alaskan sites monitored in 2009.

Site	Chicks Fledged[a]/Nest	No. of Plots	Long-term Average	Reference
St. Paul I.	0.20	6 (20)[b]	0.24 (29)[b]	McClintock et al. 2010
St. George I.	0.16	10 (329)	0.25 (33)	Shannon et al. 2010
Buldir I.	0.43	N/A[c] (23)	0.17 (21)	Freeman et al. 2010

[a]Total chicks fledged/Total nests.

[b]Sample size in parentheses represents the number of nests used to calculate productivity and the number of years used to calculate the long-term average. Current year not used in long-term average.

[c]Not applicable or not reported.

Populations.–Red-legged kittiwakes declined at St. Paul Island both overall and between 2000 and 2009, whereas numbers were stable during both time periods at St. George and Buldir islands (Figure 20).

Diet.–Diet samples from Bogoslof Island were dominated by myctophids and small invertebrates (Figure 21). Diets collected from St. Paul Island contained predominately pollock and squid. Red-legged kittiwakes from St. George and Buldir islands ate myctophids along with varying amounts of other small fish and invertebrates.

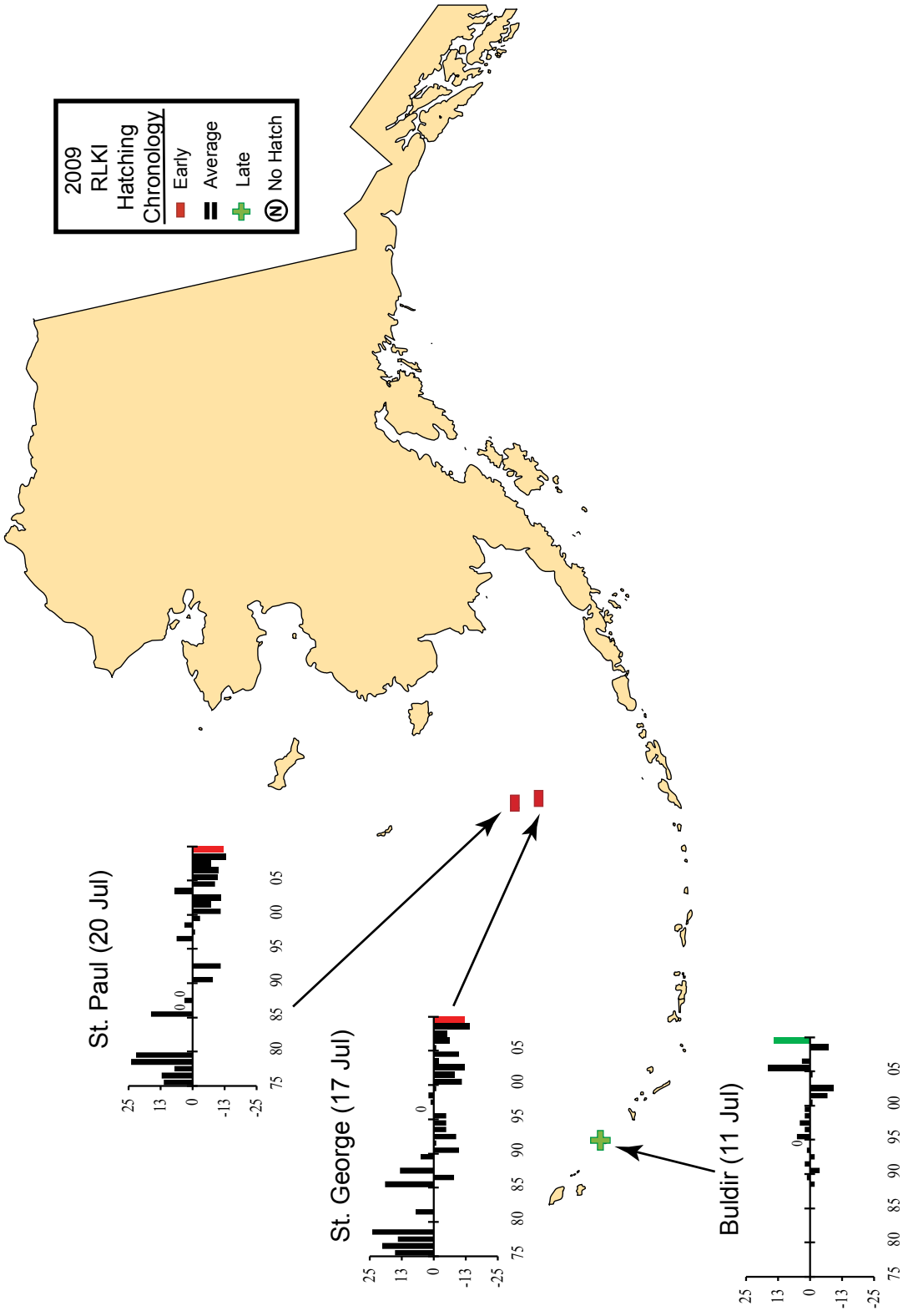


Figure 18. Hatching chronology of red-legged kittiwakes at Alaskan sites. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

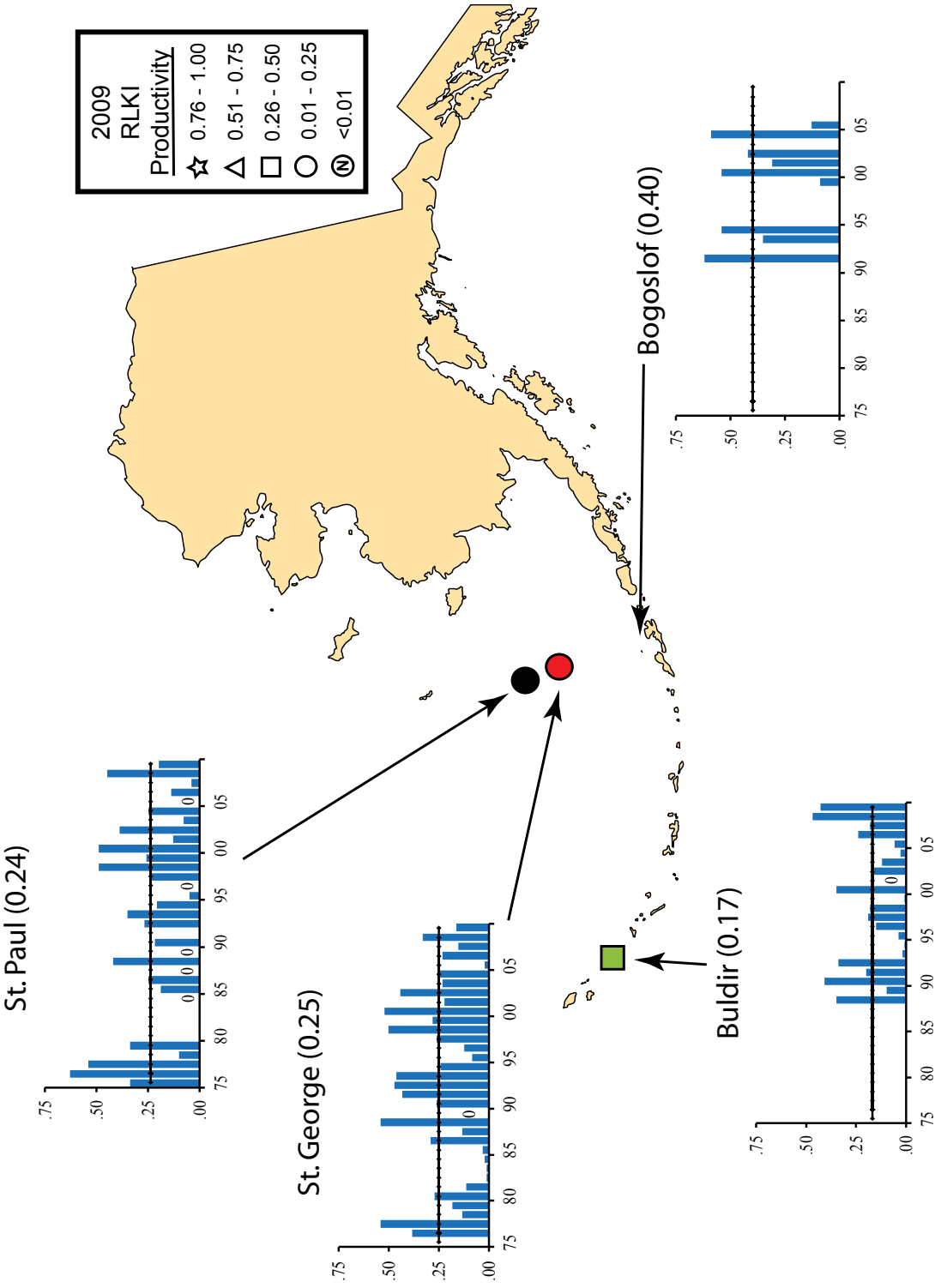


Figure 19. Productivity of red-legged kittiwakes (chicks fledged/nest) at Alaskan sites. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

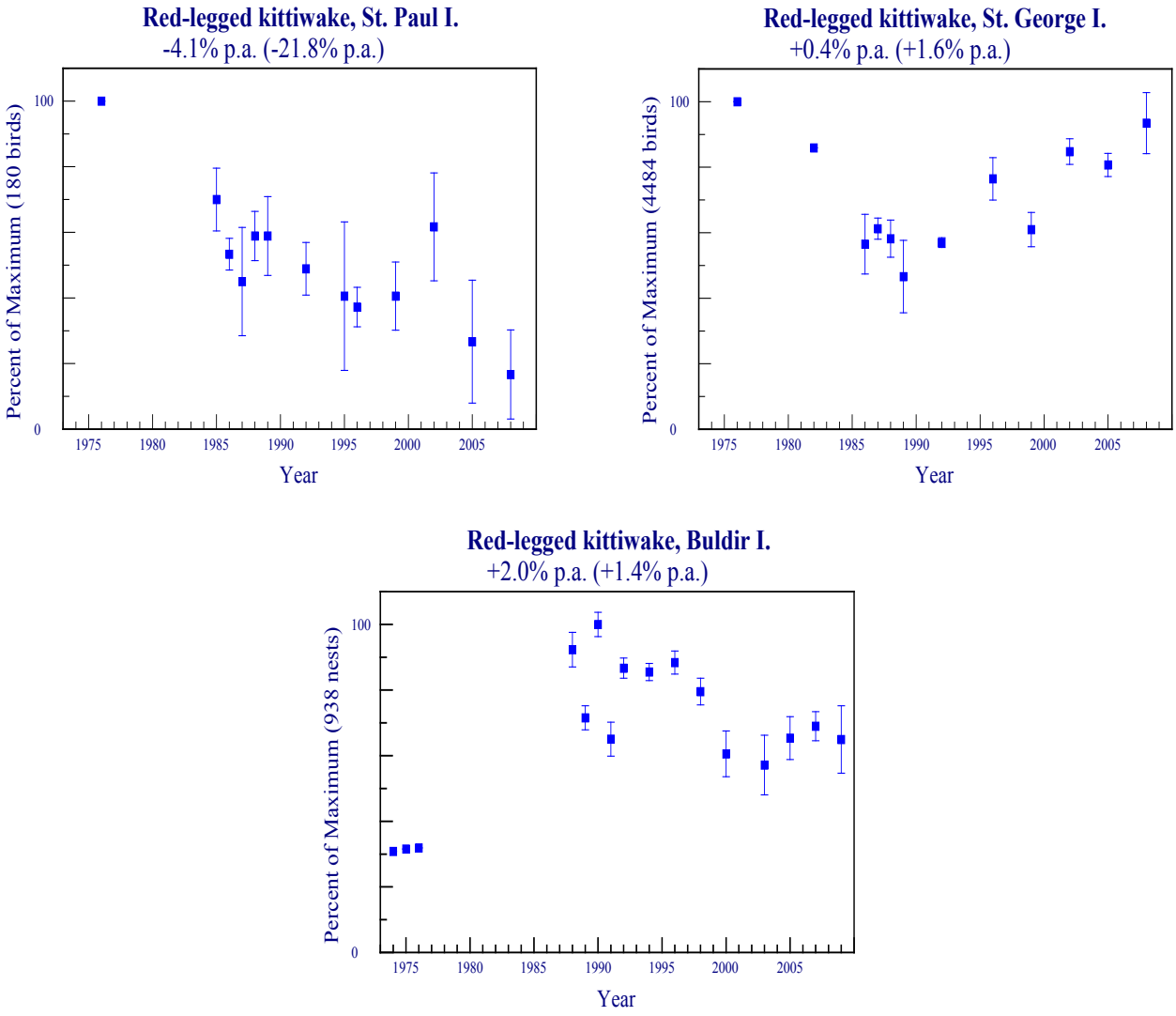
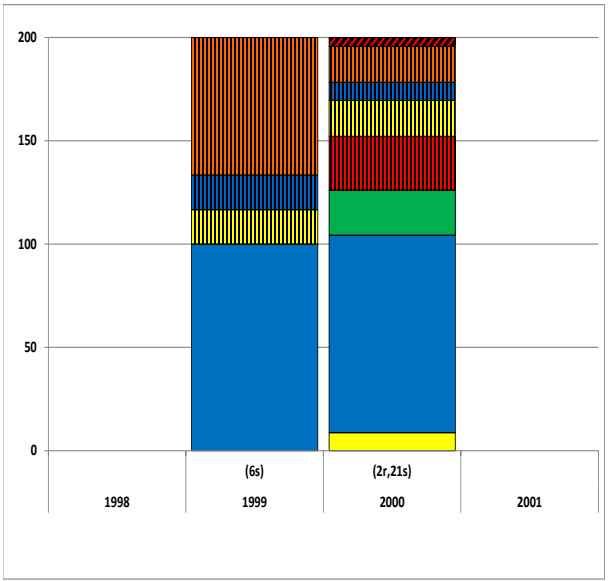
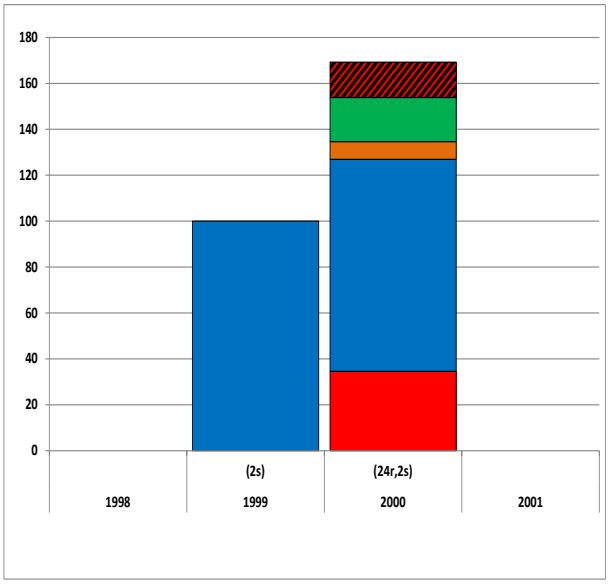


Figure 20. Trends in populations of red-legged kittiwakes at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (2000-2009, in parentheses). "N/A" indicates that insufficient data were available.

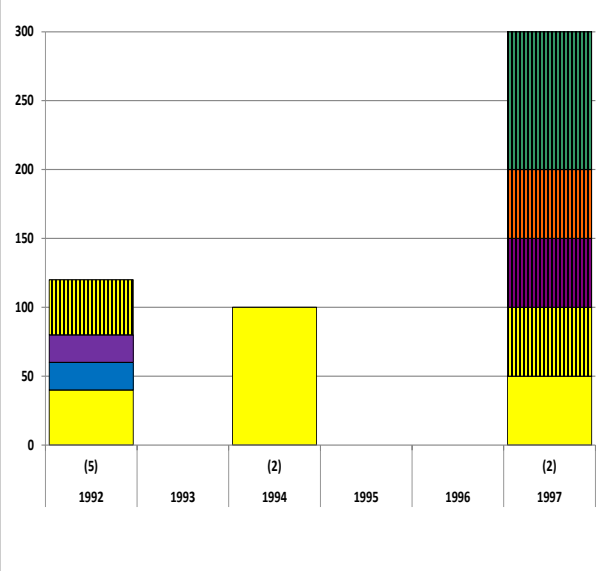
Red-legged kittiwake, Bogoslof I.
(adult diets – regurgitation and stomach samples)



Red-legged kittiwake, Bogoslof I.
(chick diets – regurgitation and stomach samples)



Red-legged kittiwake, St. Paul I.
(adult diets – stomach samples)



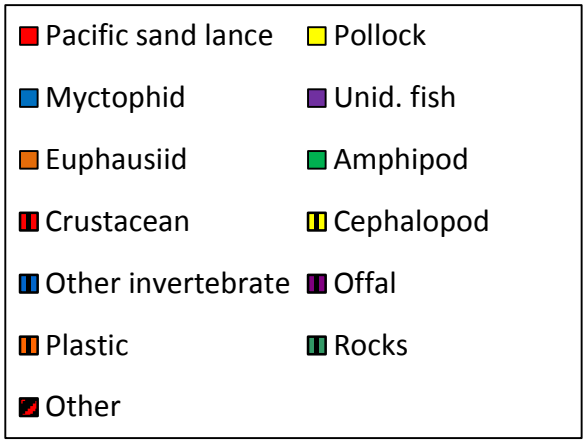
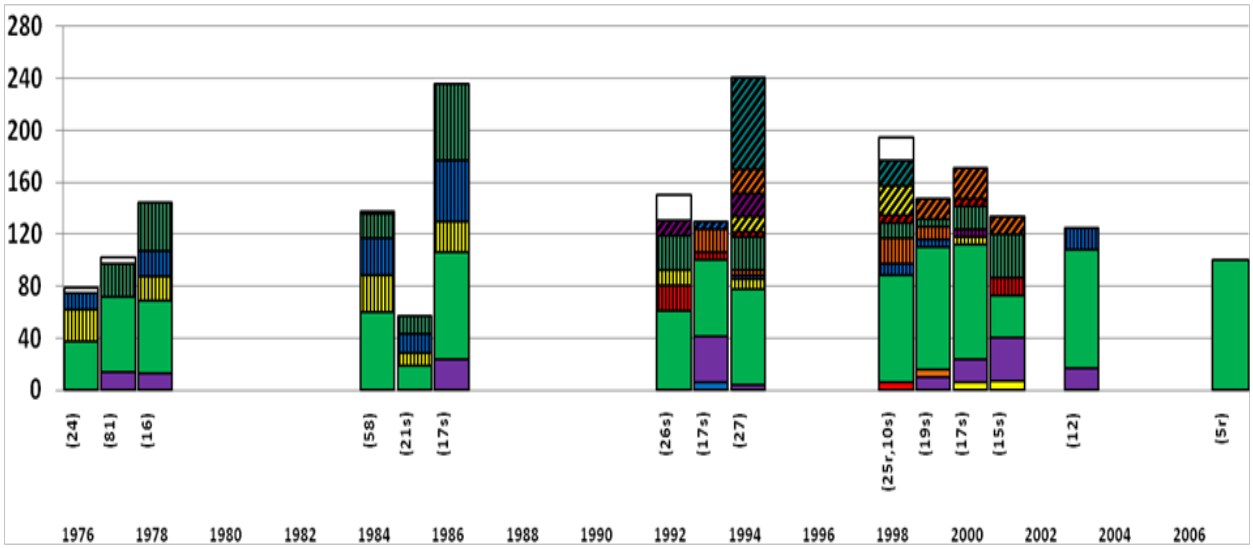
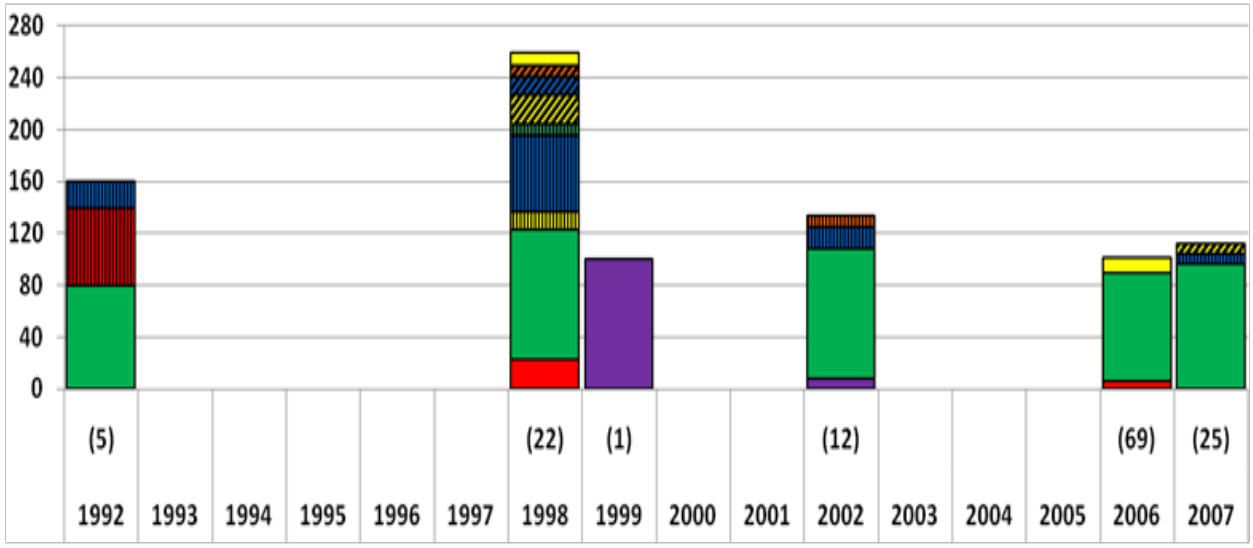


Figure 21. Diets of red-legged kittiwakes at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Red-legged kittiwake, St. George I.
(adult diets – regurgitation and stomach samples)



Red-legged kittiwake, St. George I.
(chick diets – regurgitation samples)



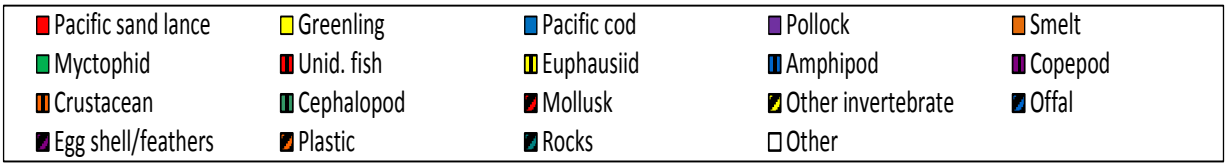


Figure 21 (continued). Diets of red-legged kittiwakes at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Red-legged kittiwake, Buldir I.
(adult diets – regurgitation samples)

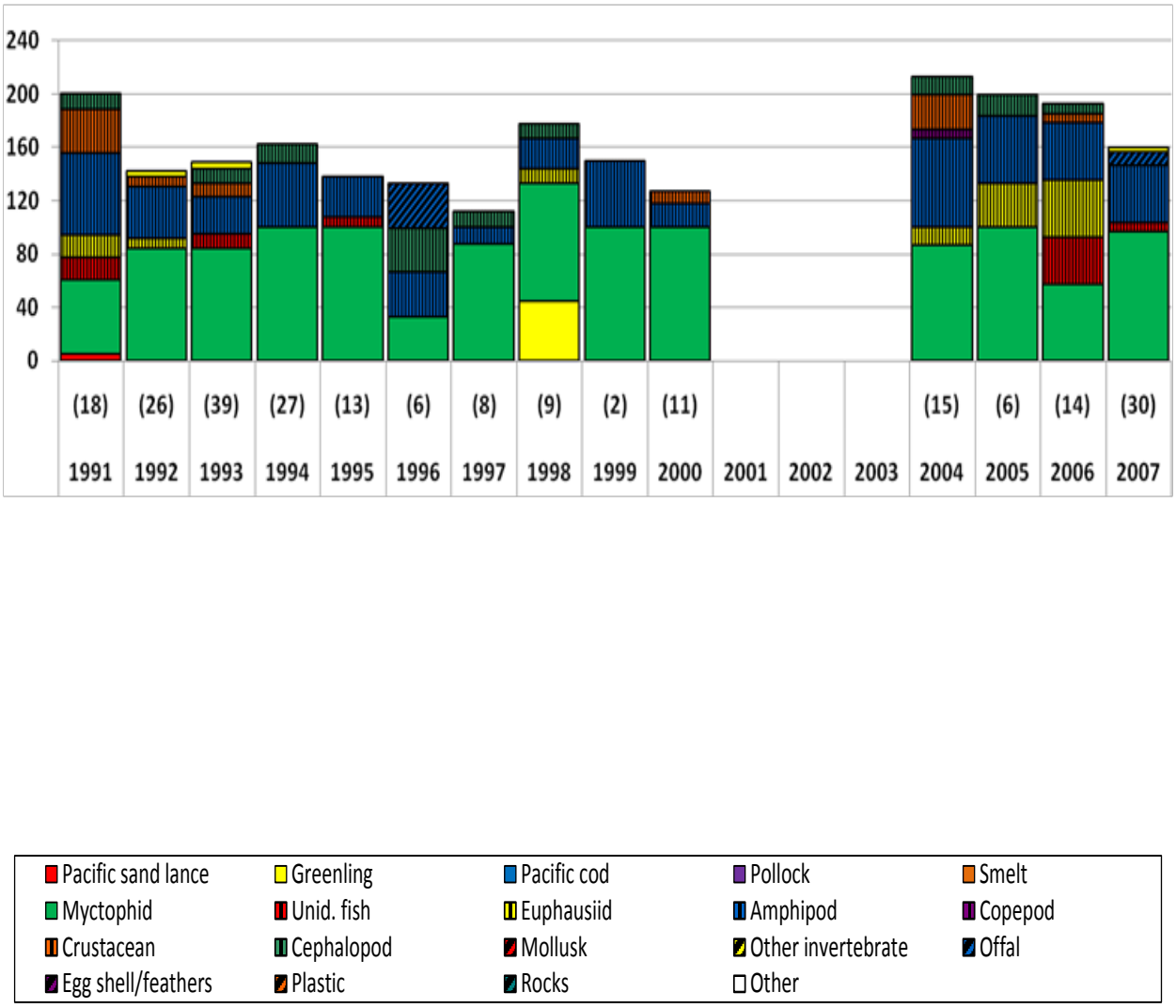


Figure 21 (continued). Diets of red-legged kittiwakes at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Glaucous-winged gull (*Larus glaucescens*)

Breeding chronology.–In 2009, glaucous-winged gull mean hatch date was average at Aiktak and Chowiet islands, early at St. Lazaria Island and late at Buldir Island (Table 13, Figure 22).

Table 13. Hatching chronology of glaucous-winged gulls at Alaskan sites monitored in 2009.

Site	Median	Mean	Long-term Average	Reference
Buldir I.	—	4 Jul (10)[a]	24 Jun[b] (9)[a]	Freeman et al. 2010
Aiktak I.	—	11 Jul (38)	9 Jul[b] (14)	Sapora et al. 2010
Chowiet I.	—	1 Jul (36)	4 Jul[b] (3)	Andersen et al. 2010
St. Lazaria I.	22 Jun (58)	26 Jun (58)	5 Jul[b] (10)	L. Slater Unpubl. Data

[a]Sample size in parentheses represents the number of nest sites used to calculate the mean or median hatch date and the number of years used to calculate the long-term average. Current year not included in long-term average.

[b]Mean of annual means.

Productivity.–Glaucous-winged gull hatching success in 2009 was above average at Buldir Island, average at Chowiet and St. Lazaria islands, and below average at Aiktak Island (Table 14, Figure 23).

Table 14. Reproductive performance of glaucous-winged gulls at Alaskan sites monitored in 2009.

Site	Hatching Success[a]	No. of Plots	Long-term Average	Reference
Buldir I.	0.67	N/A[b] (9)[c]	0.31 (16)[c]	Freeman et al. 2010
Aiktak I.	0.16	4 (345)	0.66 (14)	Sapora et al. 2010
Chowiet I.	0.43	3 (269)	0.37 (7)	Andersen et al. 2010
St. Lazaria I.	0.46	N/A	0.56 (15)	L. Slater Unpubl. Data

[a]Total chicks/Total eggs.

[b]Not applicable or not reported.

[c]Sample size in parentheses represents the number of eggs used to calculate hatching success and the number of years used to calculate the long-term average. Current year not used in long-term average.

Populations.–We found a negative trend at Buldir Island in all years, and between 2000 and 2009 as well (Figure 24). Gull numbers were stable in all years at Kasatochi Island and increased there between 2000 and 2009. Bogoslof Island gull populations were stable for all years but there were insufficient data to assess recent trends. Aiktak Island numbers were stable overall, with an increasing trend between 2000 and 2009. At Middleton Island, gull populations exhibited an increasing trend over all years and the numbers appear to have stabilized in recent years. Gulls showed an increasing trend during both time periods at St. Lazaria Island.

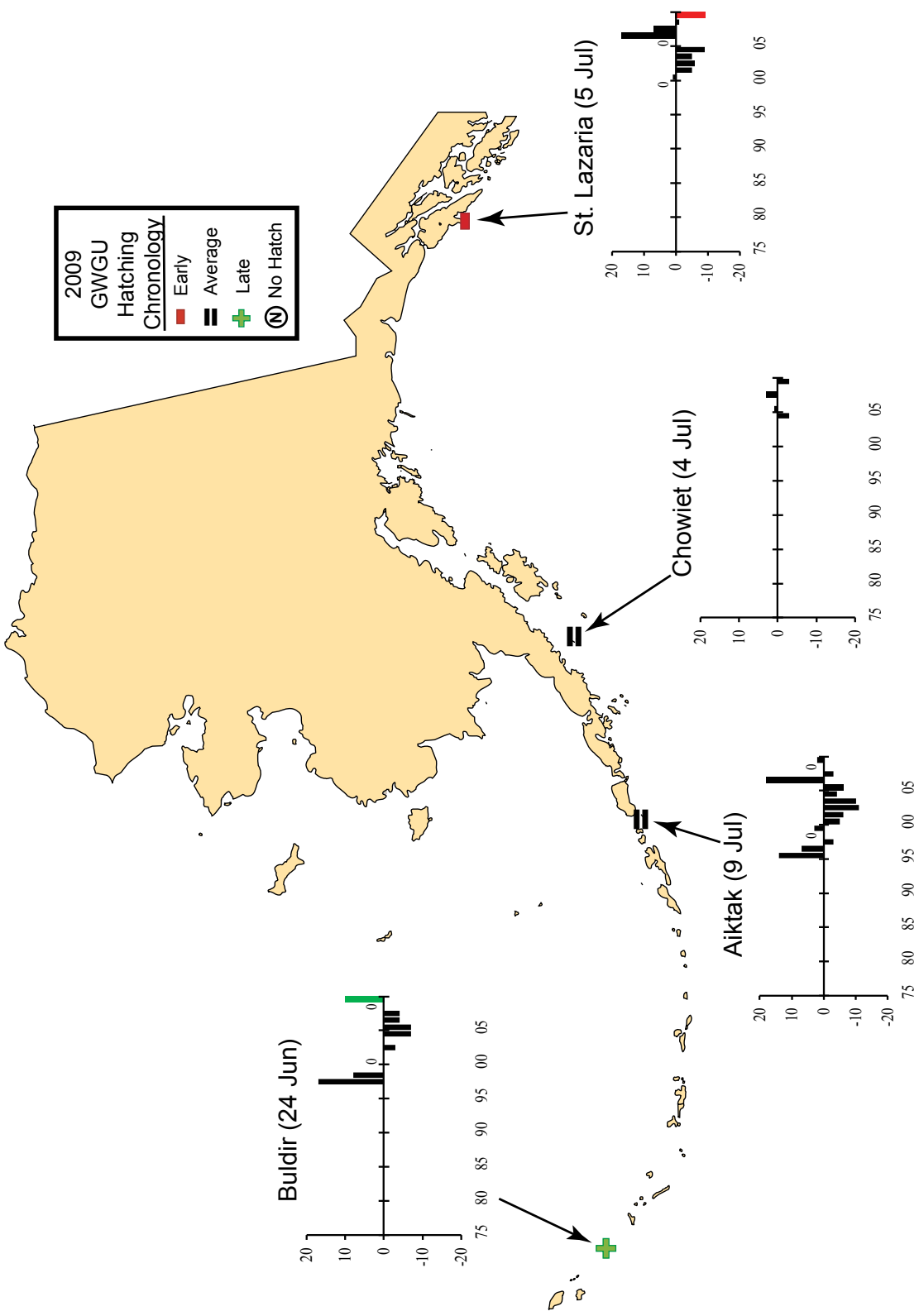


Figure 22. Hatching chronology of glaucous-winged gulls at Alaskan sites. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

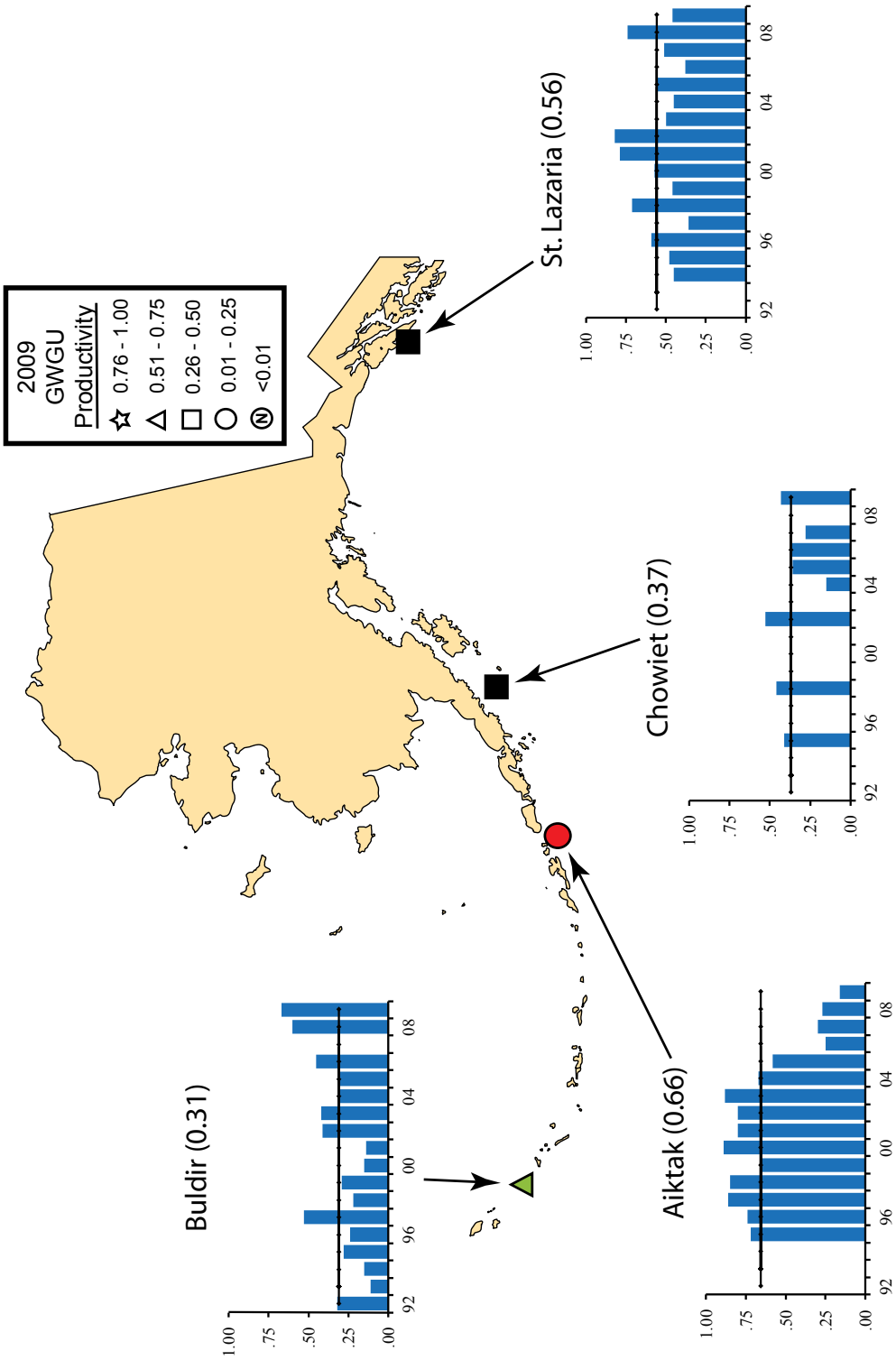


Figure 23. Productivity of glaucous-winged gulls (hatching success) at Alaskan sites. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

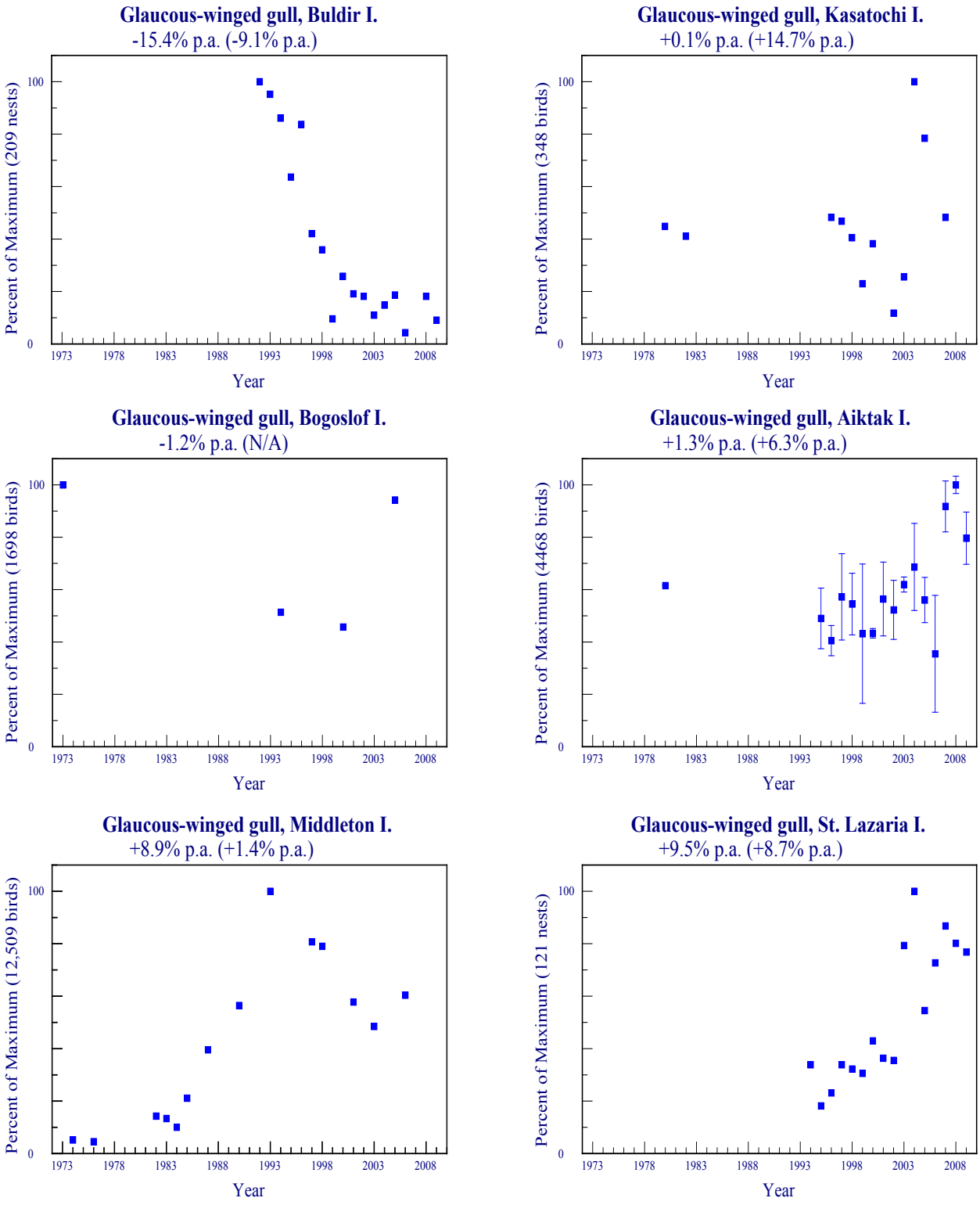


Figure 24. Trends in populations of glaucous-winged gulls at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (2000-2009, in parentheses). "N/A" indicates that insufficient data were available.

Diet.–Glaucous-winged gulls from Buldir Island predominately ate invertebrates and avian prey, while gulls from Prince William Sound predominately ate fish and invertebrate prey at Eleanor Island, and offal, fish, and invertebrates at the Shoup Bay colony (Figure 25). A small sample from St. Lazaria Island included mollusks, sand lance, and unidentified fish. Glaucous-winged gulls from Aiktak Island predominately ate sand lance, herring and other fish.

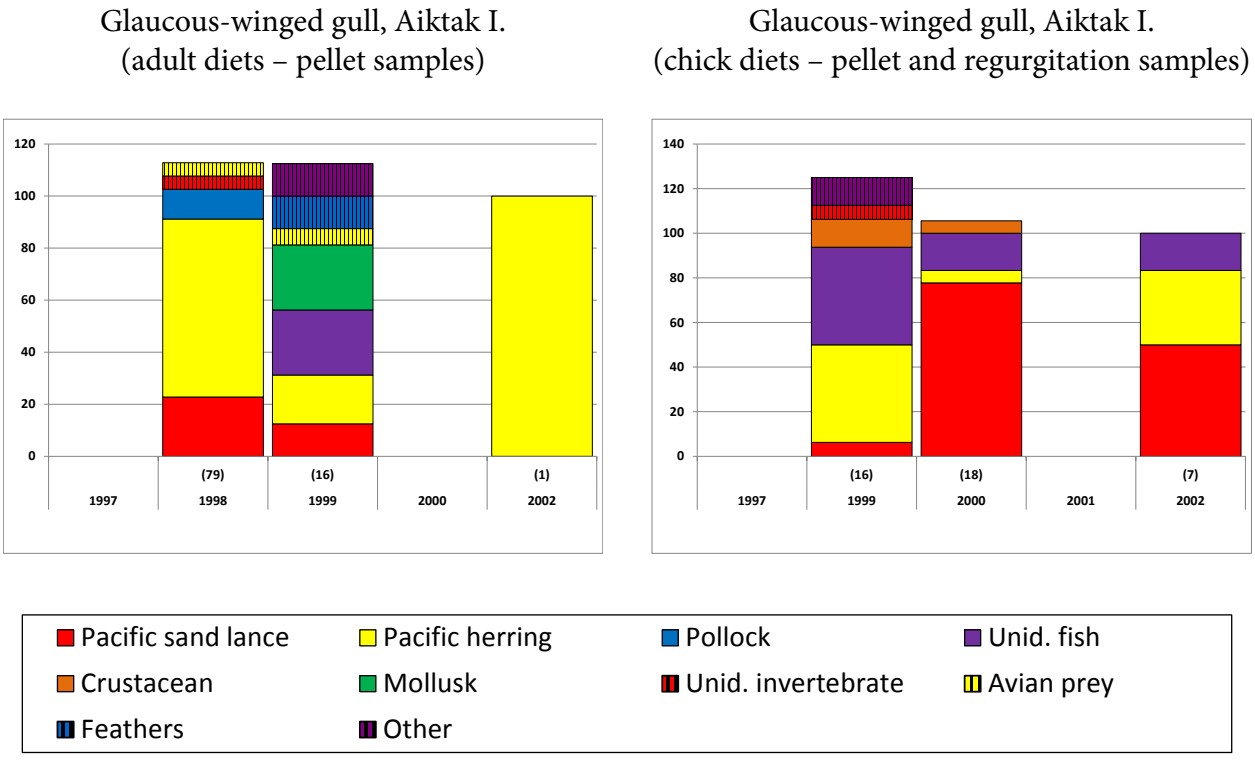


Figure 25. Diets of glaucous-winged gulls at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

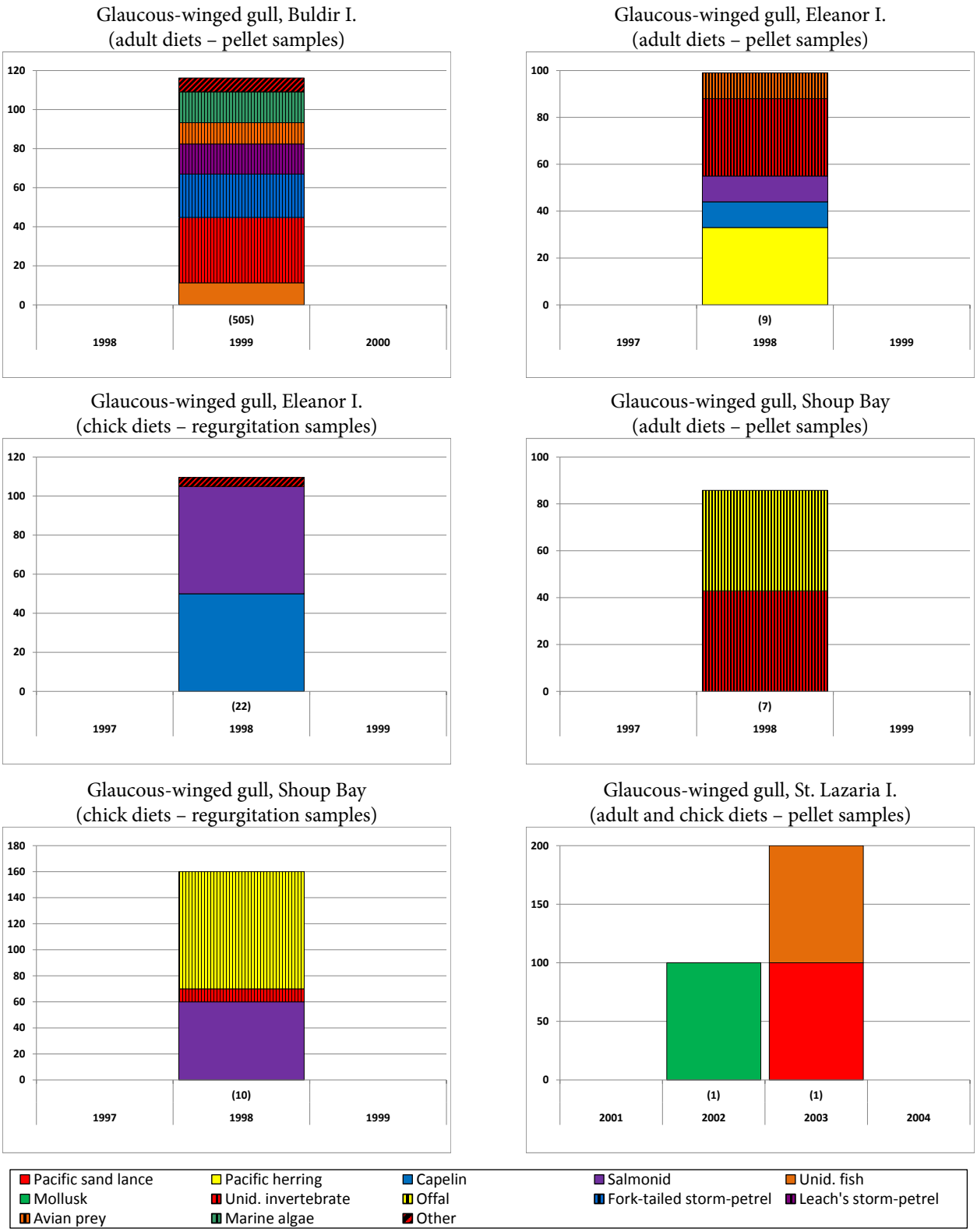


Figure 25 (continued). Diets of glaucous-winged gulls at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Common murre (*Uria aalge*)

Breeding chronology.–Timing of common murre nesting events in 2009 was early at the Pribilof Islands, average at Chowiet and St. Lazaria islands, and later than average at East Amatuli Island (Table 15, Figure 26).

Table 15. Hatching chronology of common murres at Alaskan sites monitored in 2009.

Site	Median	Mean	Long-term Average	Reference
St. Paul I.	—	30 Jul (54)[a]	6 Aug[b] (24)[a]	McClintock et al. 2010
St. George I.	—	31 Jul (101)	5 Aug[b] (25)	Shannon et al. 2010
Chowiet I.	—	26 Jul (47)	23 Jul[b] (13)	Andersen et al. 2010
E. Amatuli I.	21 Aug (233)	20 Aug (233)	9 Aug[b] (16)	A. Kettle Unpubl. Data
St. Lazaria I.	—	10 Aug (45)	13 Aug[b] (15)	L. Slater Unpubl. Data

[a]Sample size in parentheses represents the number of nest sites used to calculate the mean or median hatch date and the number of years used to calculate the long-term average. Current year not included in long-term average.

[b]Mean of annual means.

Productivity.–Common murre productivity was below average at two monitored sites, and average at four sites in 2009 (Table 16, Figure 27).

Table 16. Reproductive performance of common murres at Alaskan sites monitored in 2009.

Site	Chicks Fledged/ Nest Site[a]	No. of Plots	Long-term Average	Reference
St. Paul I.	0.56	7 (126)[b]	0.50 (22)[b]	McClintock et al. 2010
St. George I.	0.50	8 (199)	0.50 (24)	Shannon et al. 2010
Round I.	0.00	3 (46)	0.25 (8)	Okonek et al. 2010
Aiktak I.	0.00	N/A[c] (4)	0.27 (13)	Sapora et al. 2010
Chowiet I.	0.51	10 (253)	0.51 (14)	Andersen et al. 2010
St. Lazaria I.	0.61	N/A (85)	0.52 (15)	L. Slater Unpubl. Data

[a]Since murres do not build nests, nest sites were defined as sites where eggs were laid.

[b]Sample size in parentheses represents the number of nest sites used to calculate productivity and the number of years used to calculate the long-term average. Current year not used in long-term average.

[c]Not applicable or not reported.

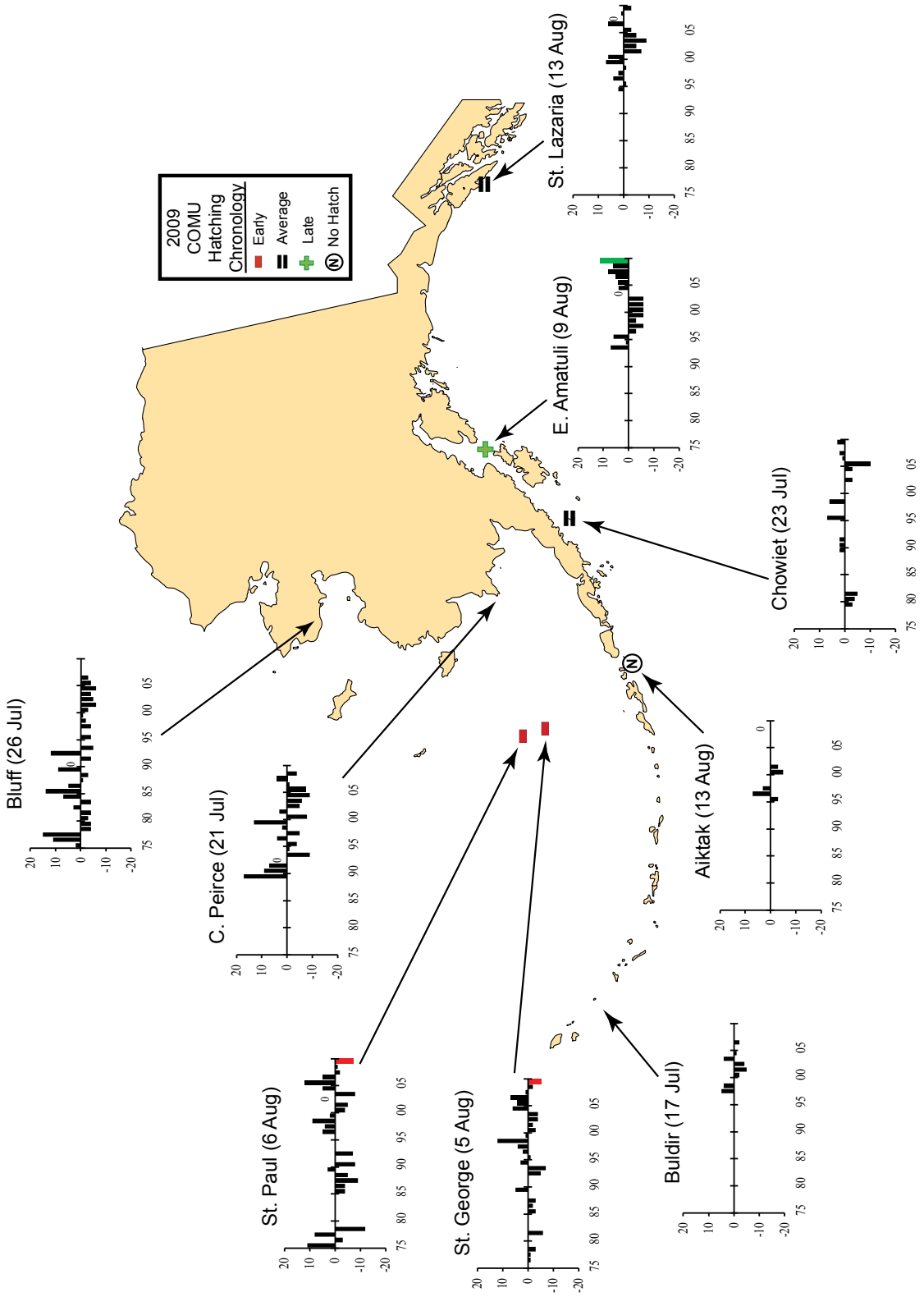


Figure 26. Hatching chronology of common murres at Alaskan sites. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

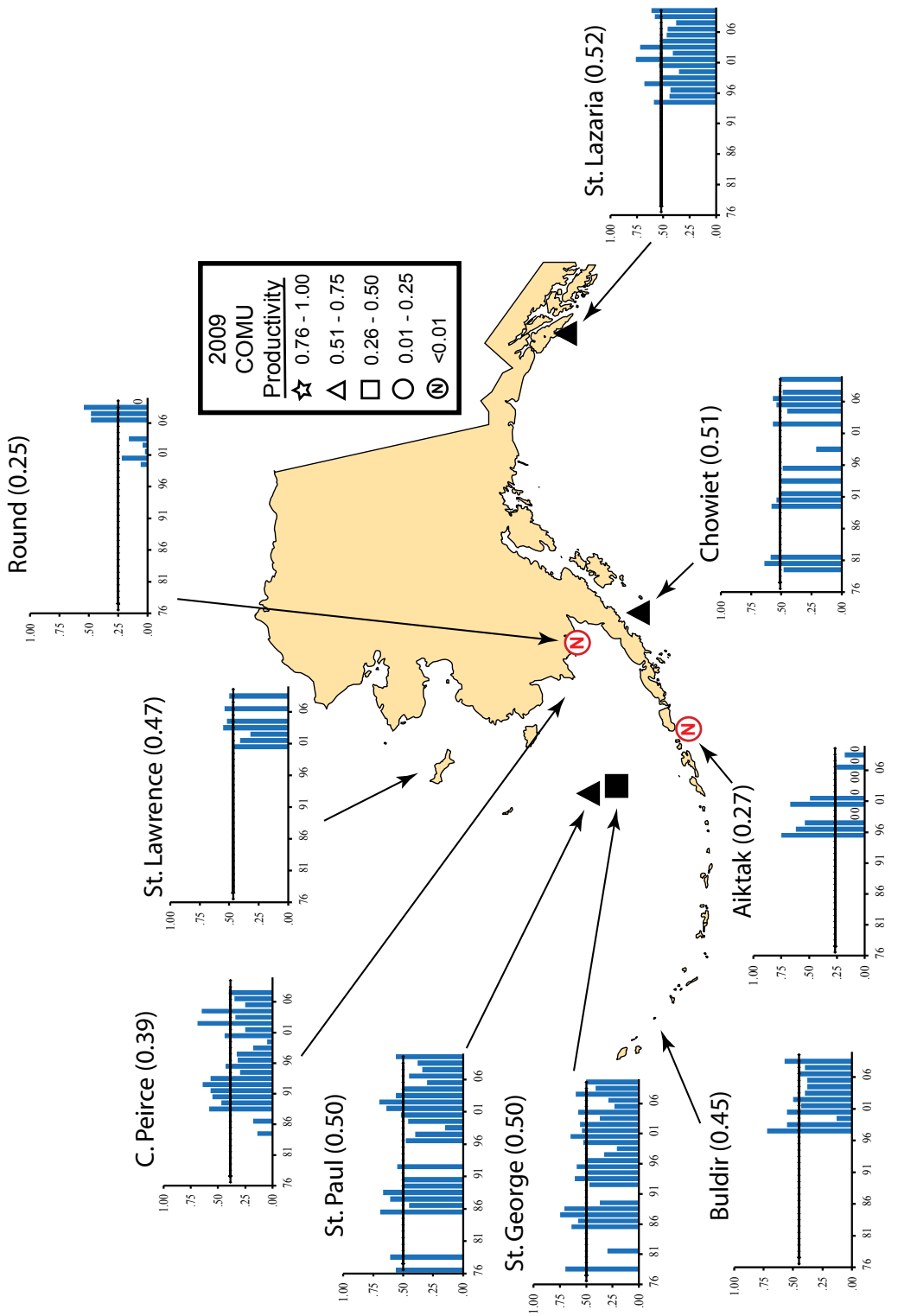


Figure 27. Productivity of common murres (chicks fledged/nest site) at Alaskan sites. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

Populations.–We found no trends in common murre numbers at Bluff either in all years or between 2000 and 2009 (Figure 28). Overall, no trend was discernible for this species at Hall Island; data were insufficient to determine a recent trend there. We found a declining trend for common murres for both time periods at St. Paul Island. Common murres at St. George Island were stable overall with a downward trend in recent years. At Cape Peirce, this species exhibited stable numbers during both time periods. Common murres increased overall, and between 2000 and 2009, at Round Island.

At sites where counts of murres are made from the water, it is difficult accurately to assign every individual to a species. As a result, common and thick-billed murres often are combined at these colonies for population trend analysis. Where murres were not identified to species, we found a positive trend at Cape Lisburne in all years followed by stable populations there between 2000 and 2009. Murre numbers increased during both time periods at Ulak Island, with an overall increase followed by a recent decline at Koniuji Island. We found a downward trend in all years at Aiktak Island, and an increase there between 2000 and 2009. No overall trend was evident at Chowiet Island but murre numbers increased there between 2000 and 2009. Middleton Island murre populations, on the other hand, showed a decline in the long term but no trend in recent years. We found no trend during either time period at St. Lazaria Island.

Diet.–Diets collected from Cape Lisburne included a variety of small fish (Figure 29). Common murres at St. Paul and St. George islands ate predominately pollock and other small fish. Diets from Chowiet Island consisted primarily of capelin, sand lance, and pollock. Common murres from the Barren Islands ate predominately capelin. Samples from Buldir and Koniuji islands contained primarily squid, pollock, and herring. Bogoslof Island diets consisted primarily of polychaetes, sand lance, and other fish. Common murres from Aiktak Island ate predominately sand lance and pollock.

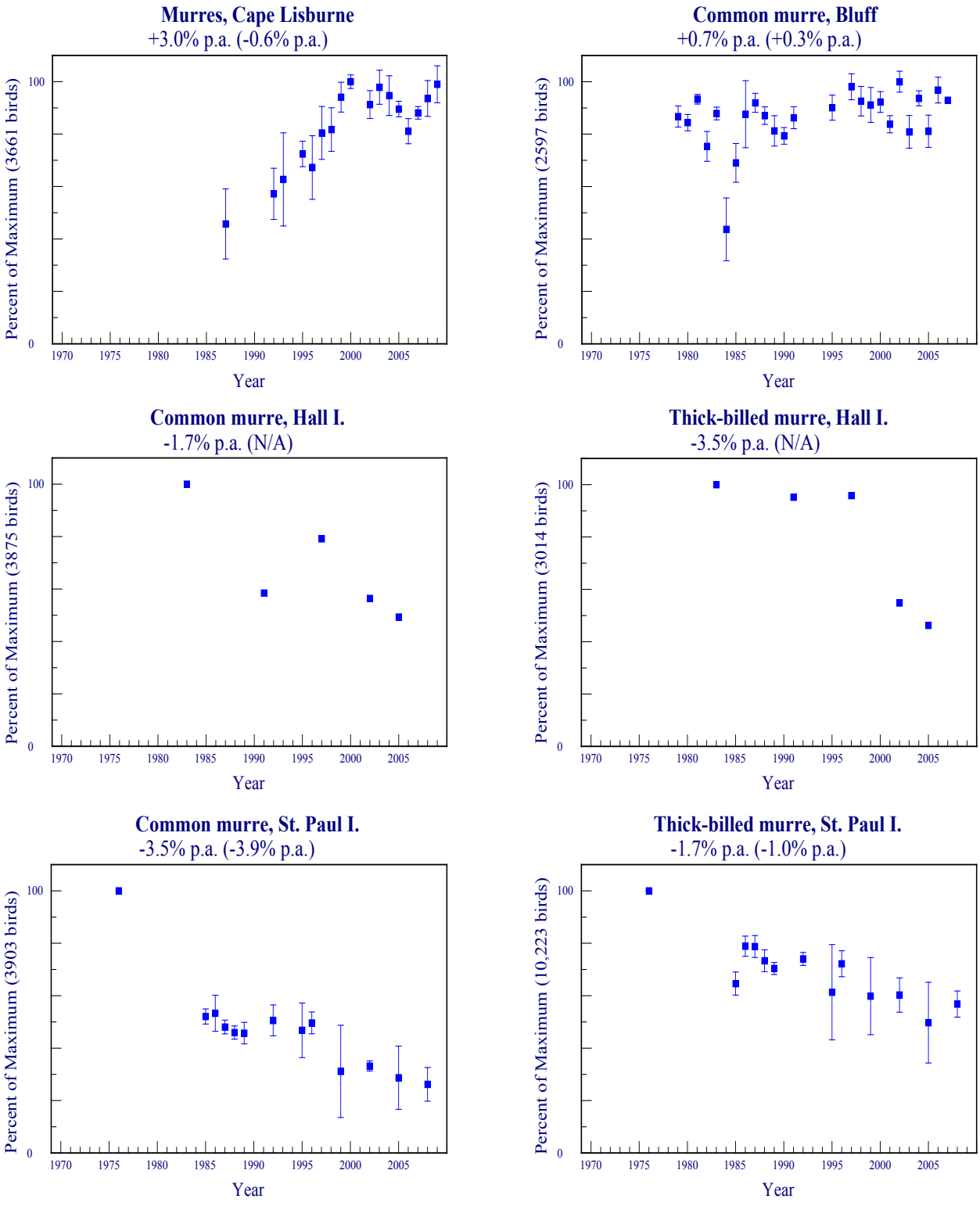


Figure 28. Trends in populations of murres at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (2000-2009, in parentheses). “N/A” indicates that insufficient data were available.

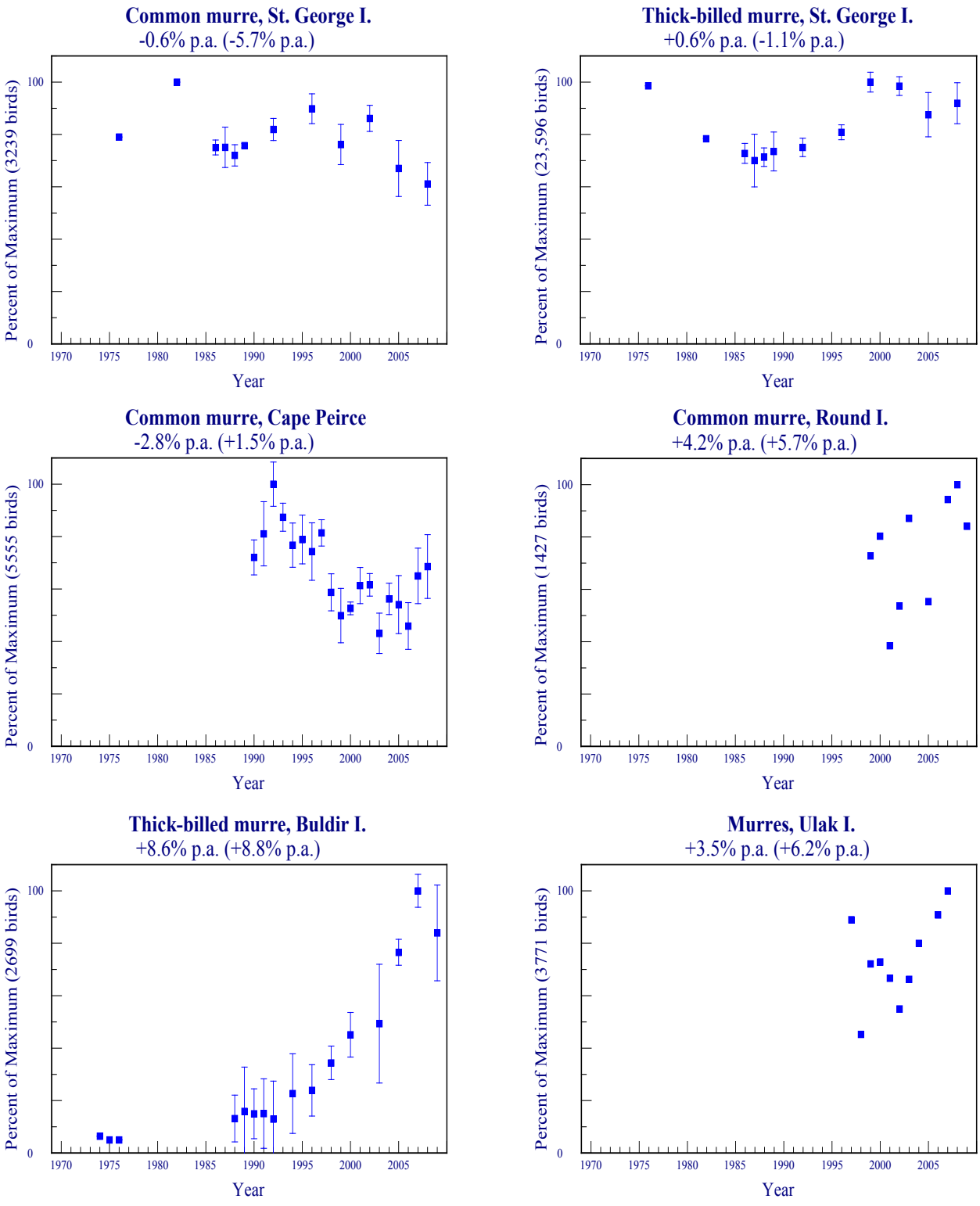


Figure 28 (continued). Trends in populations of murres at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (2000-2009, in parentheses). "N/A" indicates that insufficient data were available.

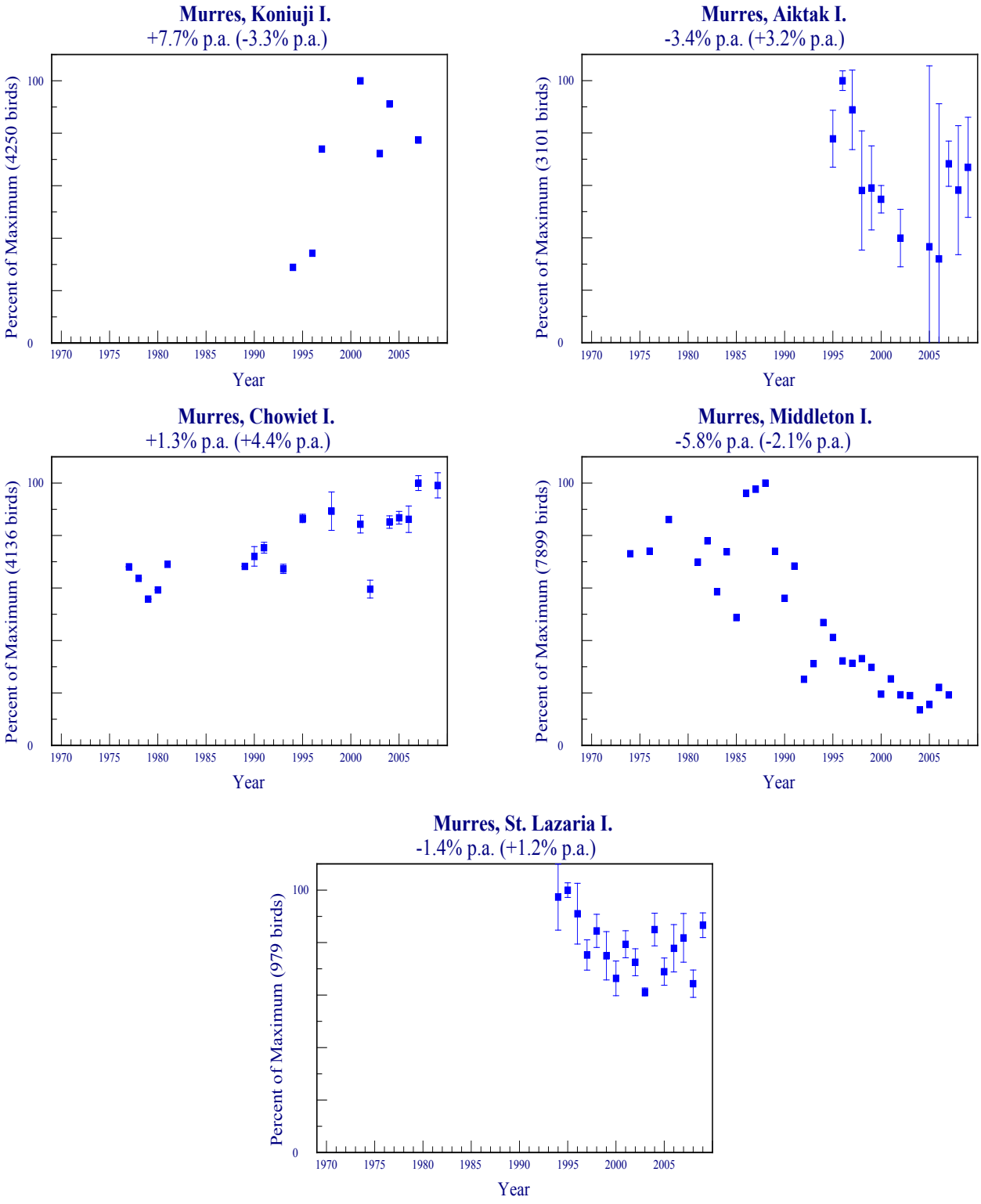
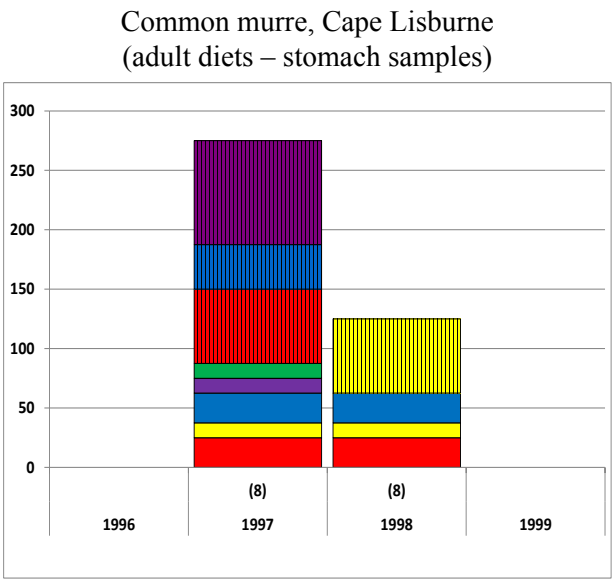
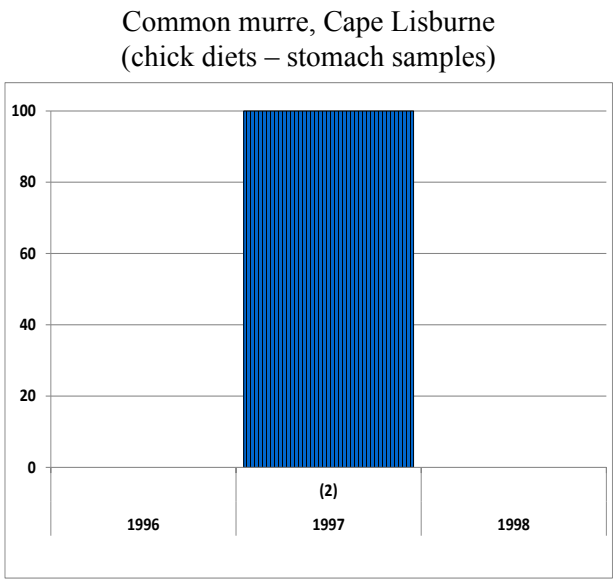
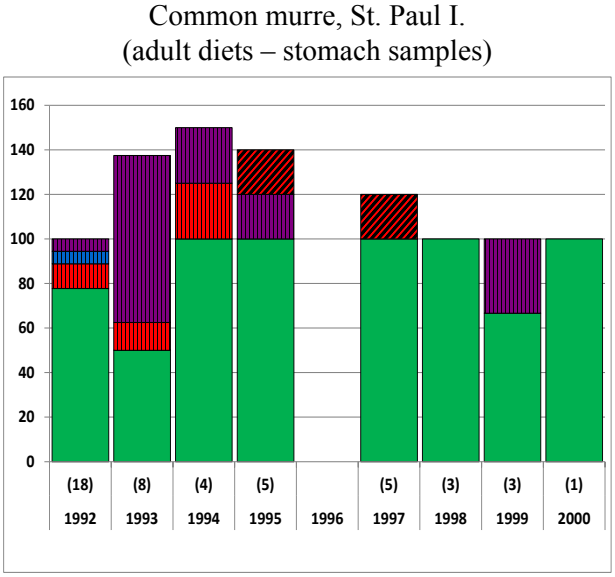


Figure 28 (continued). Trends in populations of murres at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (2000-2009, in parentheses). "N/A" indicates that insufficient data were available.







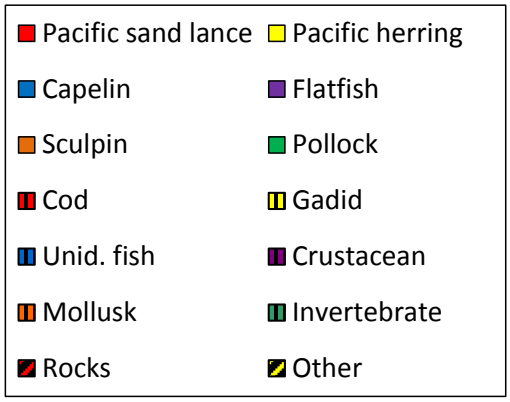


Figure 29. Diets of common murres at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

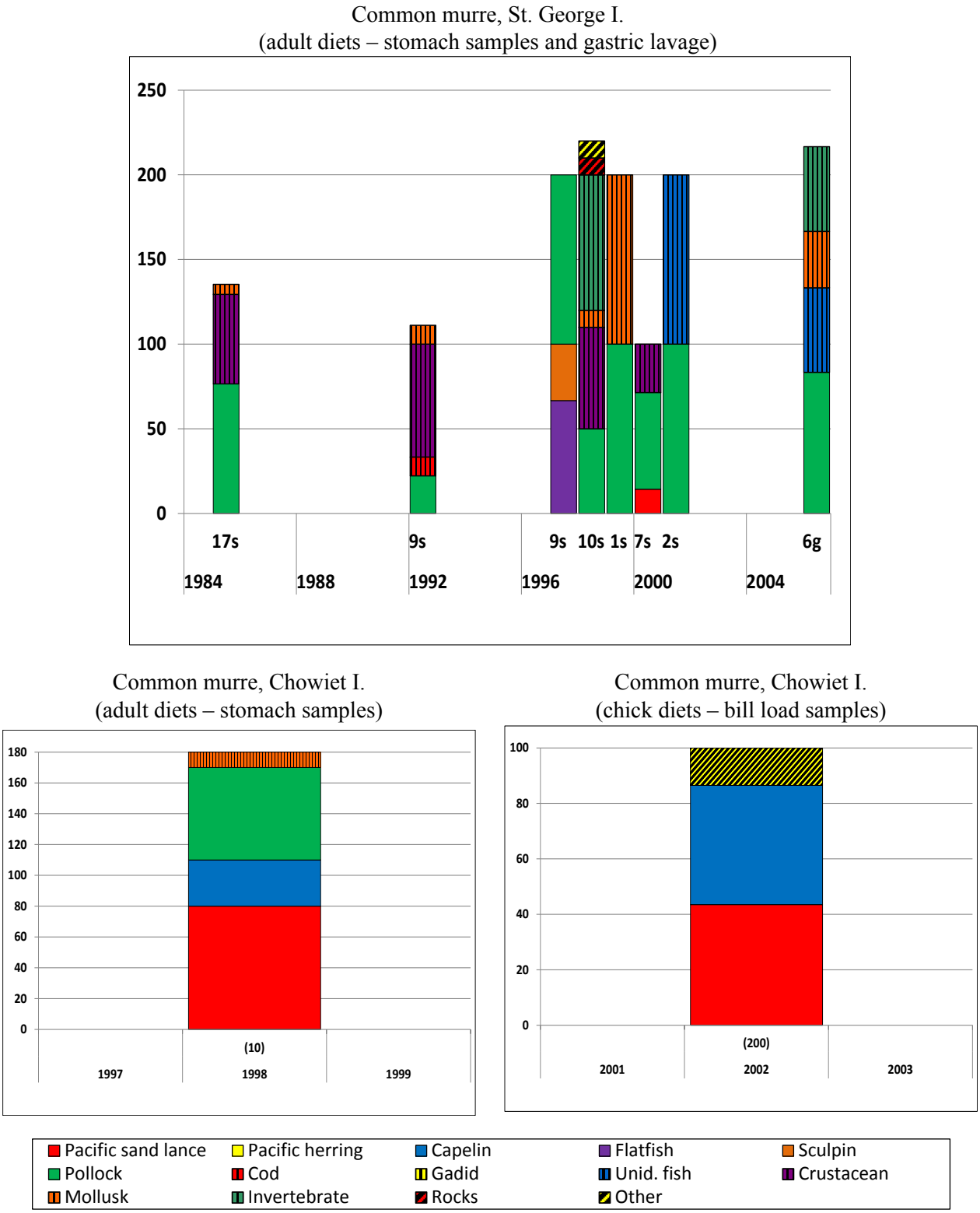


Figure 29 (continued). Diets of common murres at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

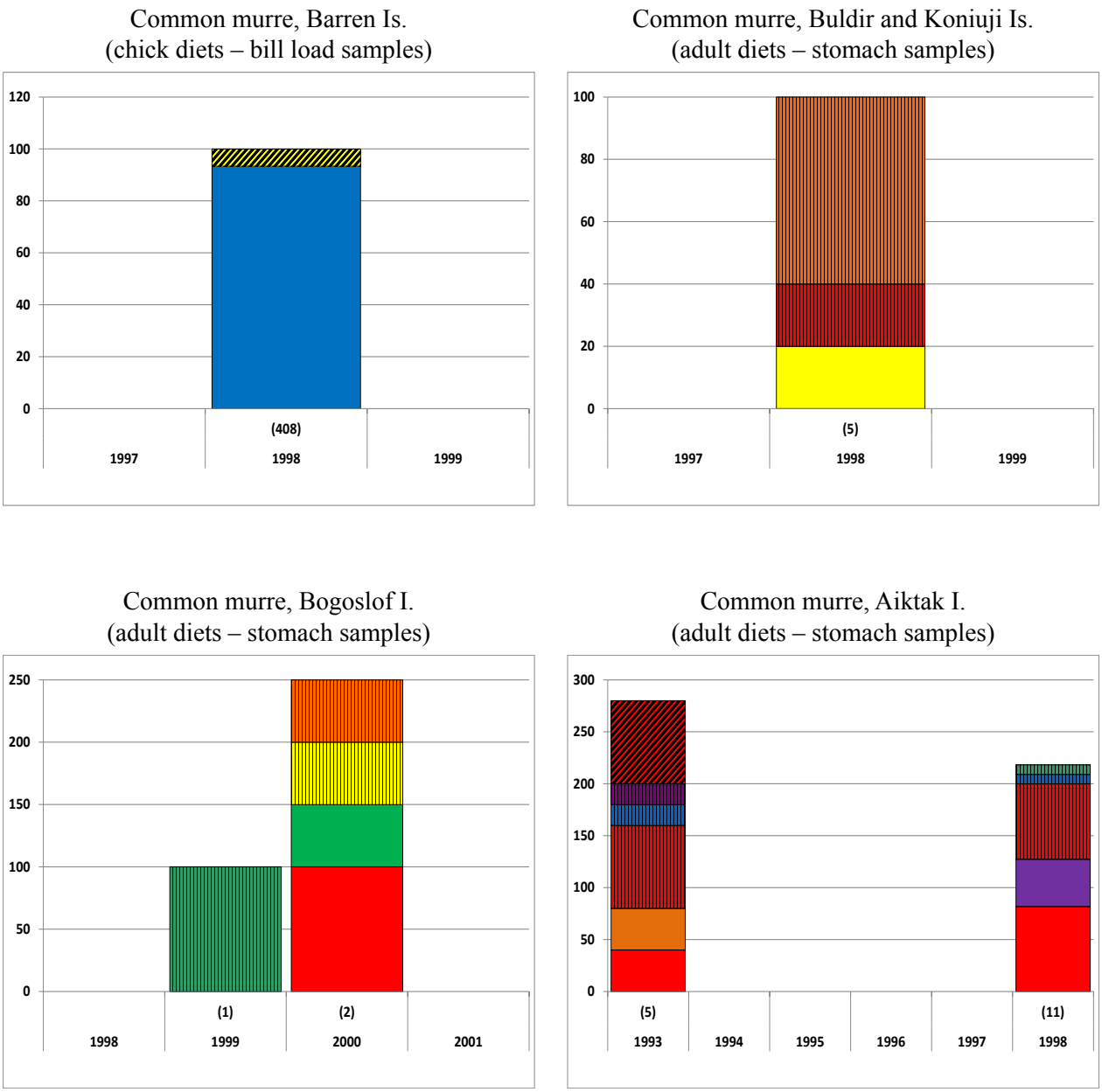


Figure 29 (continued). Diets of common murres at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Thick-billed murre (Uria lomvia)

Breeding chronology.–In 2009, thick-billed murre chick hatching was earlier than average at the Pribilof Islands, average at Chowiet and St. Lazaria islands, and late at Buldir Island (Table 17, Figure 30).

Table 17. Hatching chronology of thick-billed murres at Alaskan sites monitored in 2009.

Site	Mean	Long-term Average	Reference
St. Paul I.	1 Aug (142)[a]	6 Aug[b] (24)[a]	McClintock et al. 2010
St. George I.	27 Jul (169)	1 Aug[b] (27)	Shannon et al. 2010
Buldir I.	22 Jul (125)	18 Jul[b] (21)	Freeman et al. 2010
Chowiet I.	21 Jul (27)	20 Jul[b] (12)	Andersen et al. 2010
St. Lazaria I.	11 Aug (23)	10 Aug[b] (15)	L. Slater Unpubl. Data

[a]Sample size in parentheses represents the number of nest sites used to calculate the mean or median hatch date and the number of years used to calculate the long-term average. Current year not included in long-term average.
[b]Mean of annual means.

Productivity.–Thick-billed murre rates of success in 2009 were average at five colonies and below average at Aiktak Island (Table 18, Figure 31).

Table 18. Reproductive performance of thick-billed murres at Alaskan sites monitored in 2009.

Site	Chicks Fledged/ Nest Site[a]	No. of Plots	Long-term Average	Reference
St. Paul I.	0.52	12 (351)[b]	0.45 (24)[b]	McClintock et al. 2010
St. George I.	0.60	8 (307)	0.52 (28)	Shannon et al. 2010
Buldir I.	0.65	8 (247)	0.65 (21)	Freeman et al. 2010
Aiktak I.	0.00	N/A[c] (9)	0.27 (13)	Sapora et al. 2010
Chowiet I.	0.36	8 (153)	0.42 (14)	Andersen et al. 2010
St. Lazaria I.	0.55	N/A (42)	0.47 (15)	L. Slater Unpubl. Data

[a]Since murres do not build nests, nest sites were defined as sites where eggs were laid.
[b]Sample size in parentheses represents the number of nest sites used to calculate productivity and the number of years used to calculate the long-term average. Current year not used in long-term average.
[c]Not applicable or not reported.

Populations.–We found a negative trend for thick-billed murres at Hall Island when all years were considered but data were insufficient to determine a recent trend there (Figure 28). No trends were evident for this species during either time period at either St. Paul Island or St. George Island. Thick-billed murre populations increased both overall and between 2000 and 2009 at Buldir Island.

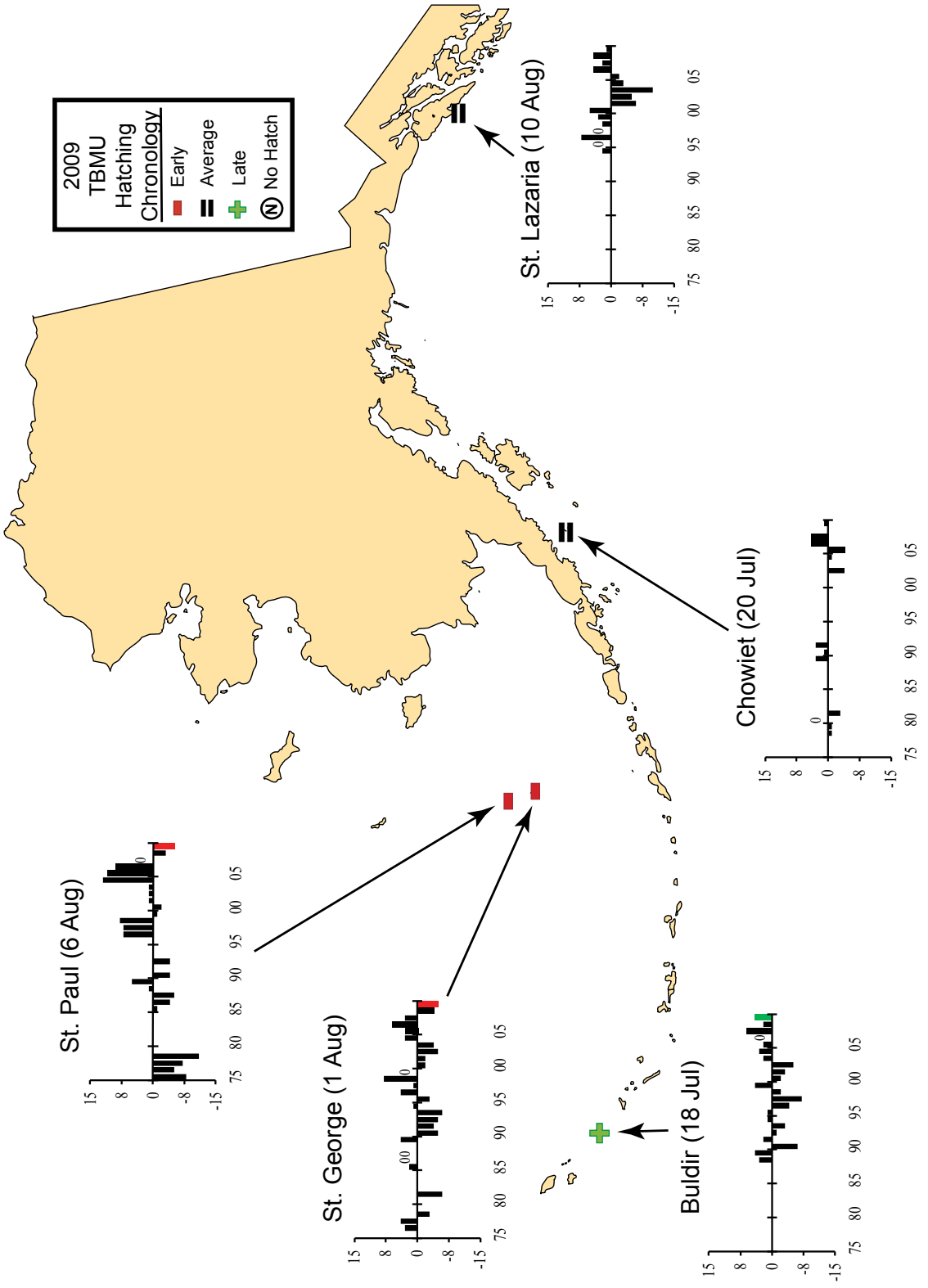


Figure 30. Hatching chronology of thick-billed murres at Alaskan sites. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

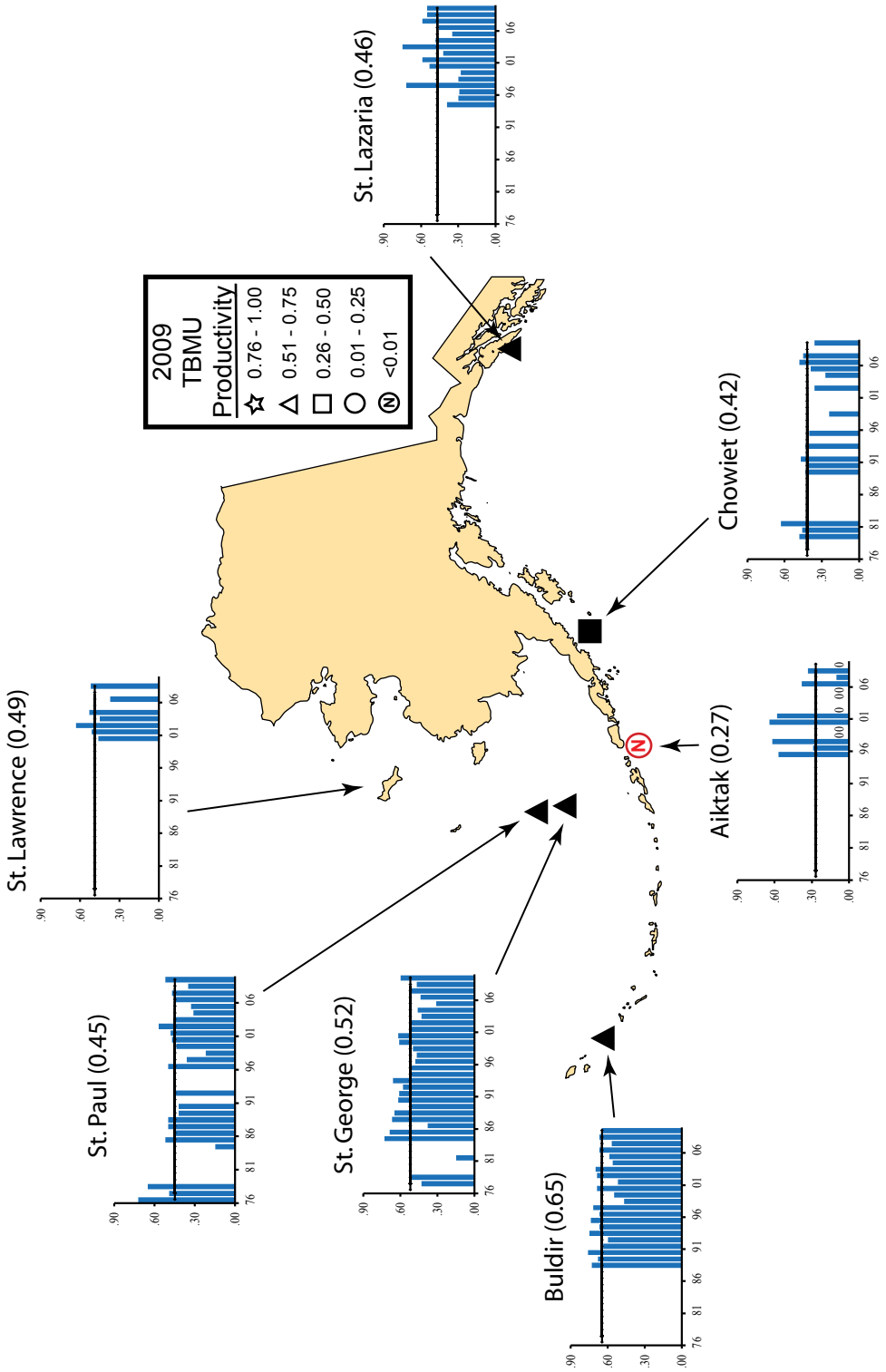


Figure 31. Productivity of thick-billed murres (chicks fledged/nest site) at Alaskan sites. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

Diet.–Diets collected from Cape Lisburne included a wide variety of small fish and invertebrates (Figure 32). Thick-billed murres from St. George Island ate primarily pollock, euphausiids and squid. Diets from St. Paul Island predominately consisted of pollock, other small fish, small crustaceans and squid. Thick-billed murres at Aiktak Island ate primarily pollock. Samples from Koniuji Island included mainly squid and small fish. Diet samples from Buldir Island included large numbers of squid, while samples from Bogoslof Island included predominantly squid along with small fish and other invertebrates. Thick-billed murres at Chowiet Island ate sandlance, capelin and squid.

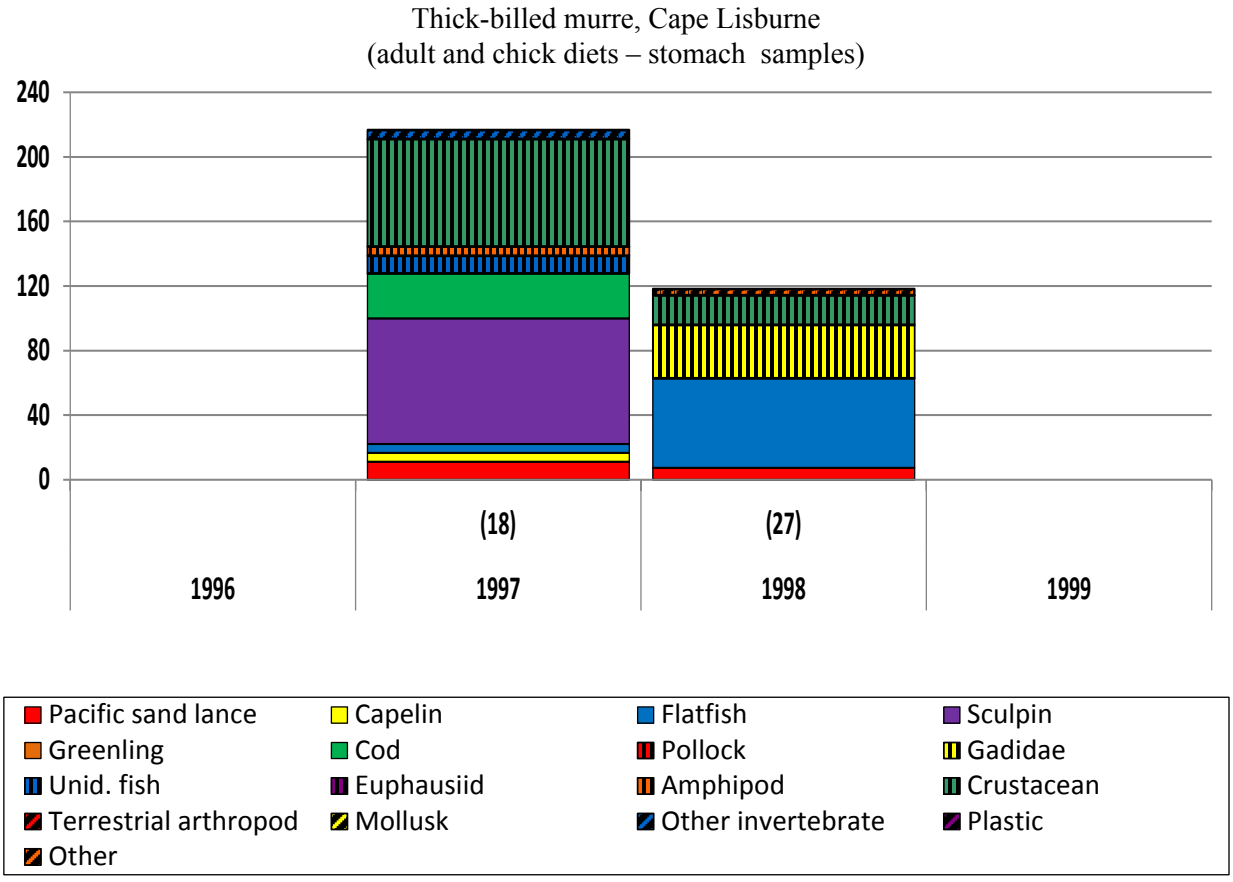


Figure 32. Diets of thick-billed murres at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

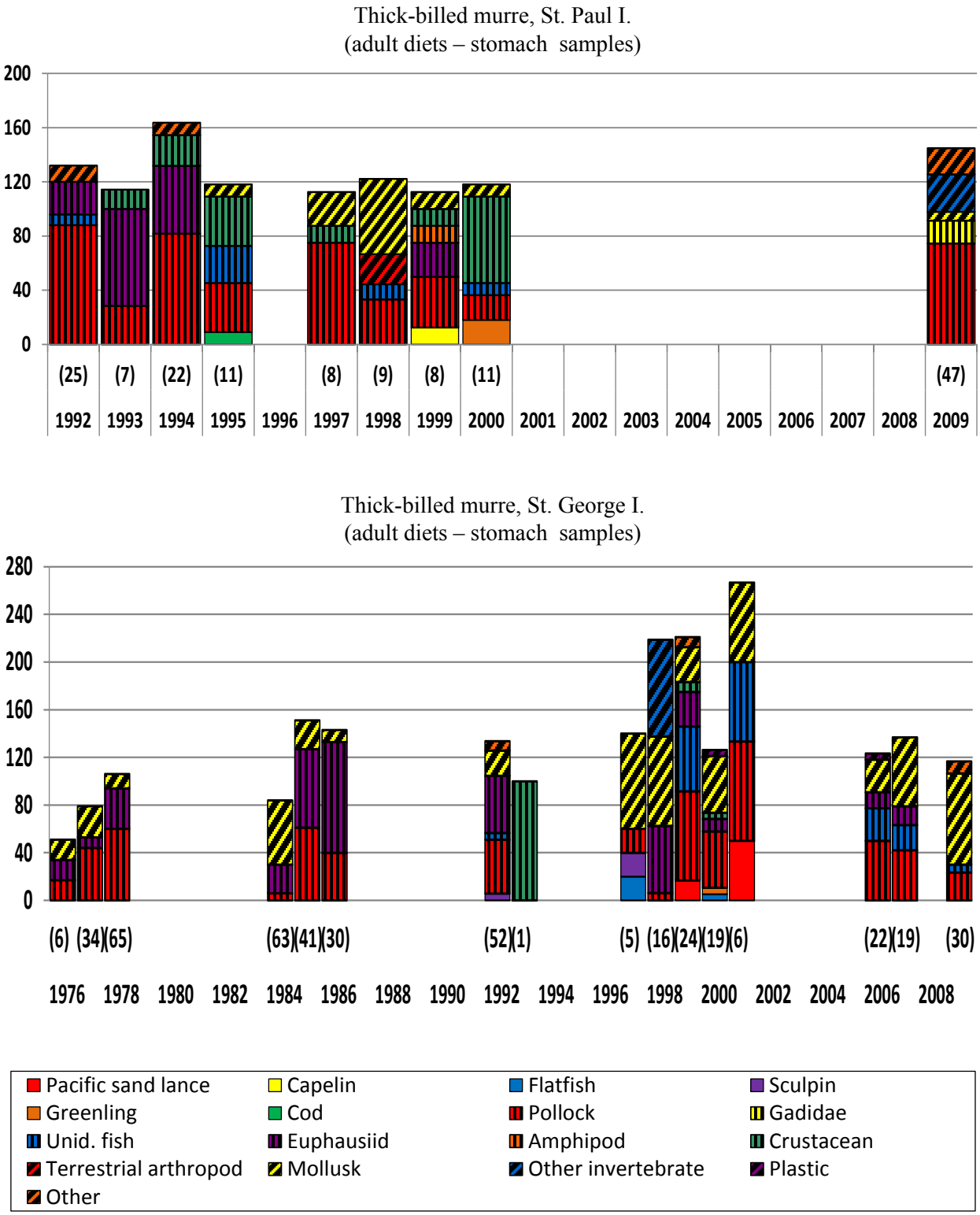


Figure 32 (continued). Diets of thick-billed murres at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

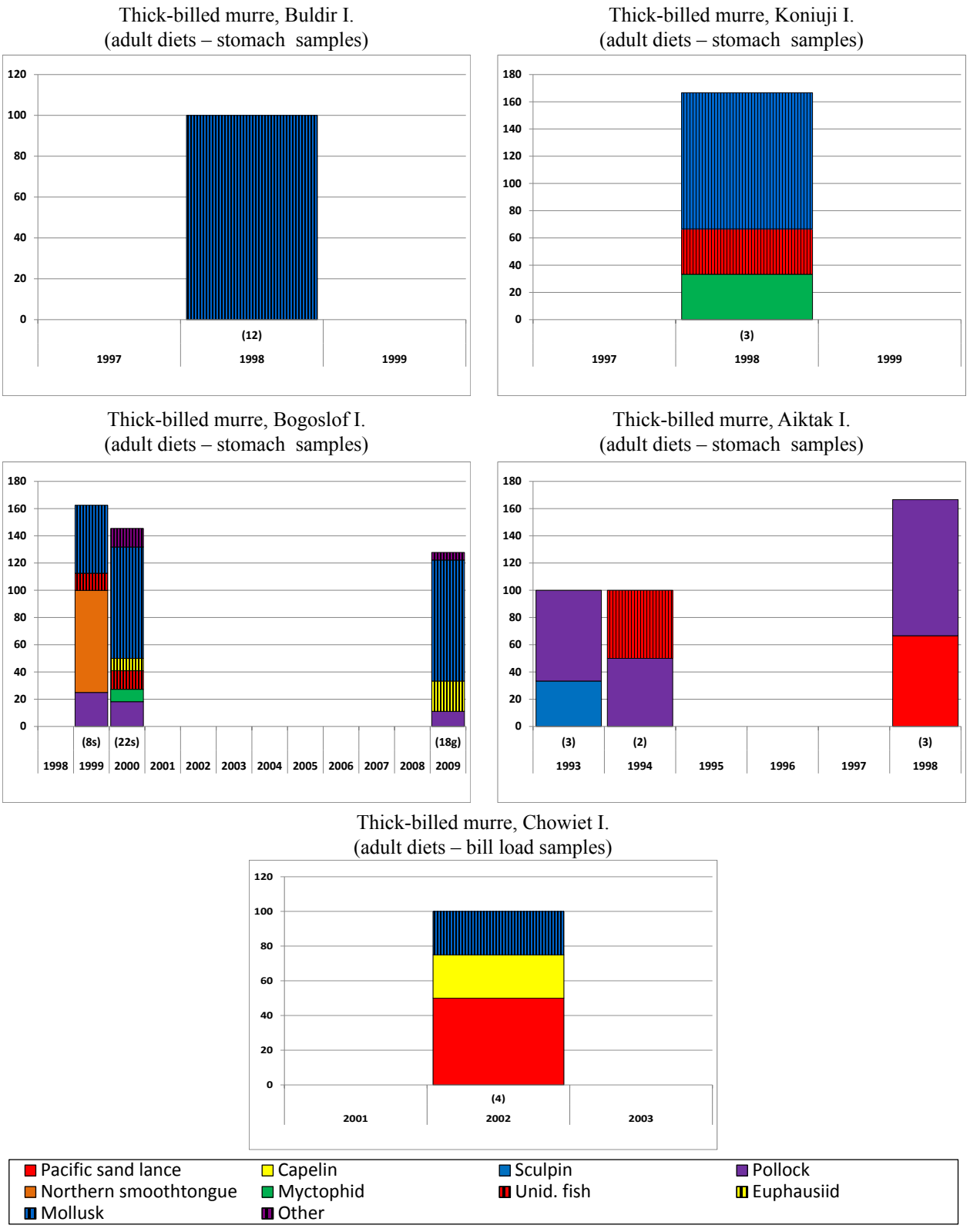


Figure 32 (continued). Diets of thick-billed murres at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Pigeon guillemot (*Cepphus columba*)

Breeding chronology.–No data.

Productivity.–No data.

Populations.–We found no population trend for pigeon guillemots in all years at Buldir Island and a decline there between 2000 and 2009 (Figure 33). Kasatochi Island guillemots were stable overall; data were insufficient to detect a recent trend there. Numbers were down in all years in Prince William Sound but data were insufficient to detect any recent trend. Guillemots exhibited no trends at St. Lazaria Island during either time period.

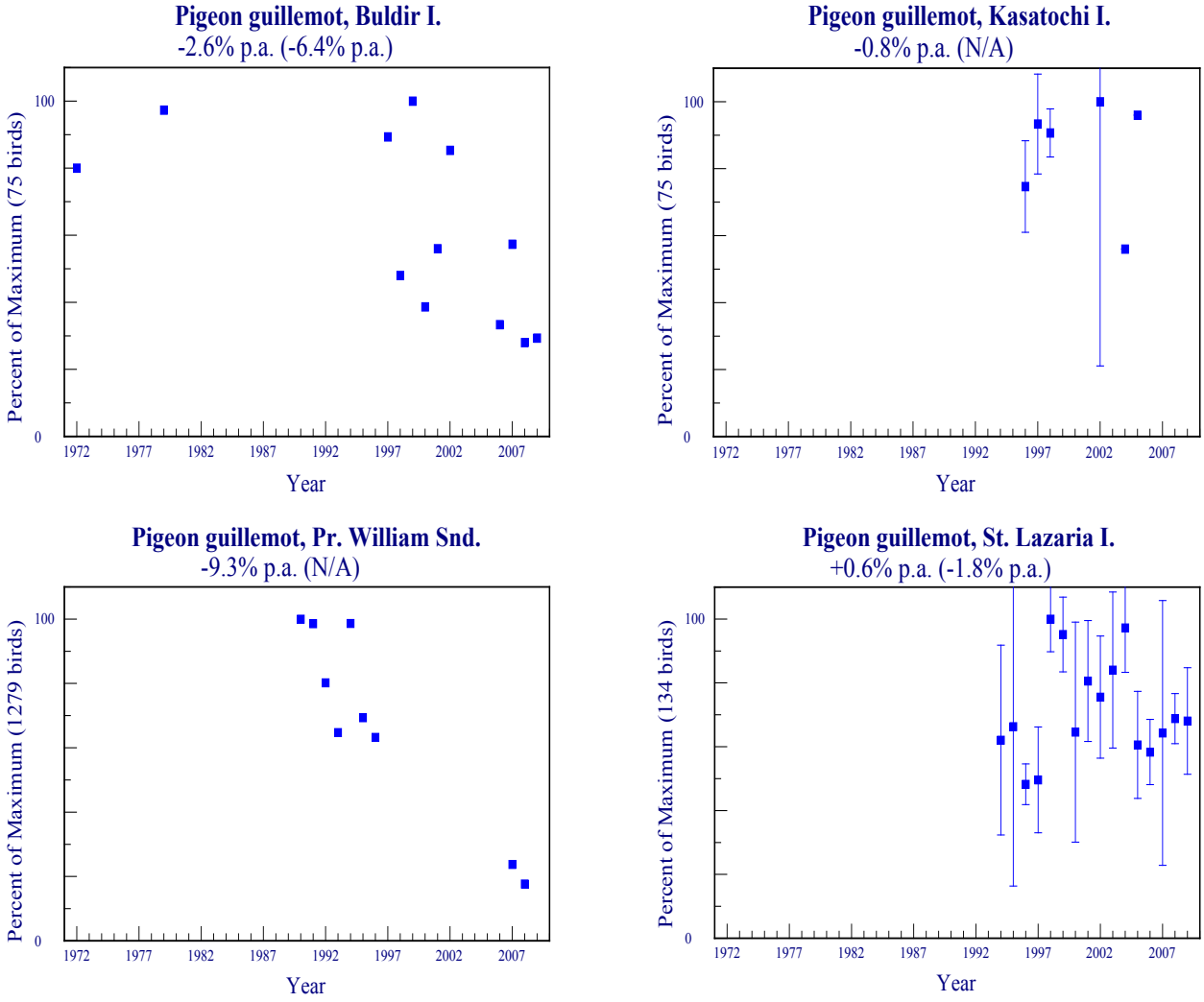


Figure 33. Trends in populations of pigeon guillemots at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (2000-2009, in parentheses). "N/A" indicates that insufficient data were available.

Diet.–Diets collected from a small sample of birds from Aiktak Island included pollock, greenling, unidentified fish, and invertebrates (Figure 34). Identified bill loads from Prince William Sound (Jackpot and Naked islands) consisted almost entirely of fish; the predominant taxa were smelt, sand lance, gunnel and gadid.

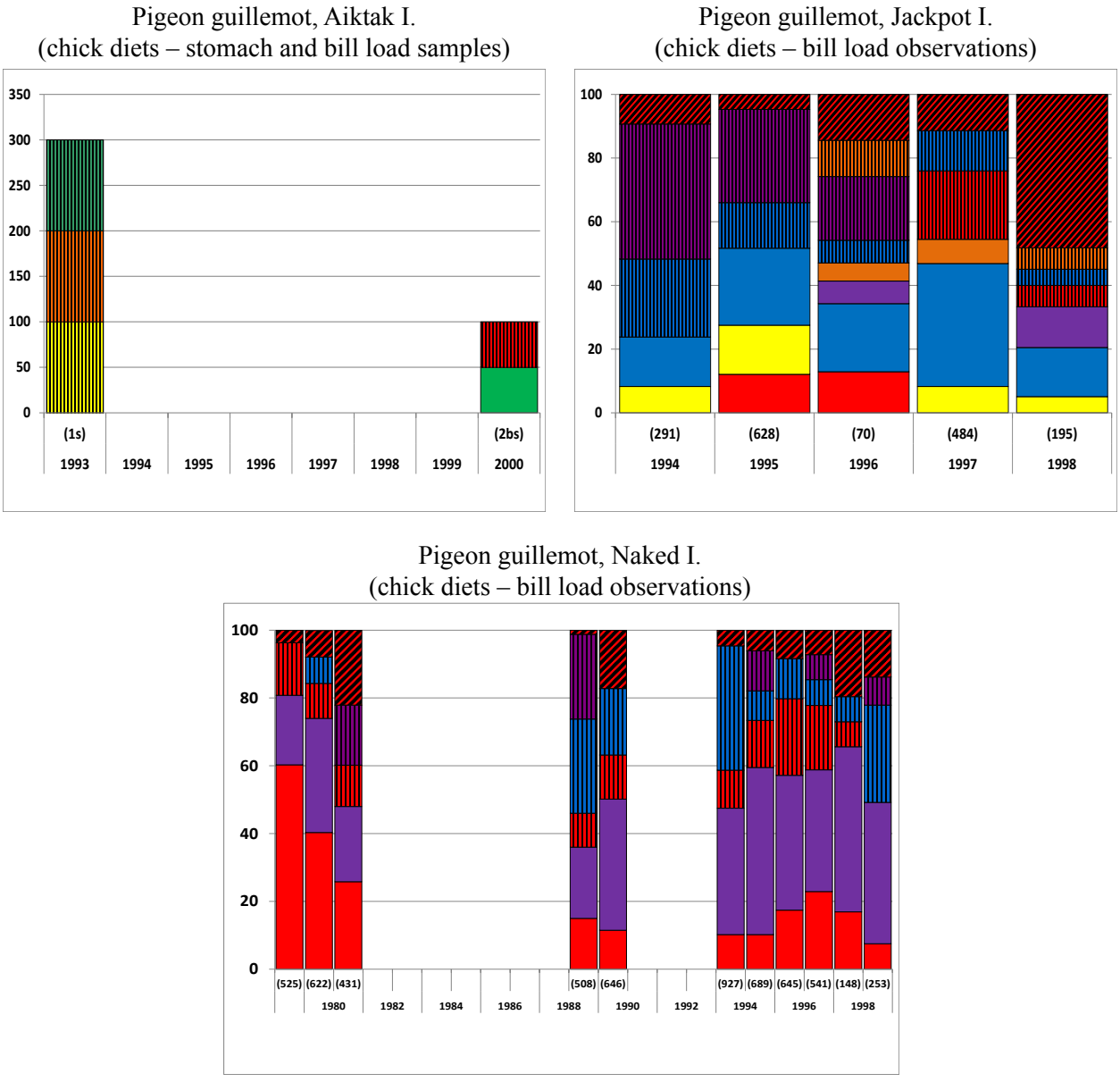


Figure 34. Diets of pigeon guillemots at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar. Because Prince William Sound samples (Jackpot and Naked islands) were reported as bill load observations, and because each bird carries only one fish per observation, the total percent occurrence for each year was 100%.

Ancient murrelet (*Synthliboramphus antiquus*)

Breeding chronology.–The mean hatching date for ancient murrelets was average at Aiktak Island, the only site where this species was monitored in 2009 (Table 19).

Table 19. Hatching chronology of ancient murrelets at Alaskan sites monitored in 2009.

Site	Mean	Long-term Average	Reference
Aiktak I.	5 Jul (83)[a]	4 Jul[b] (12)[a]	Sapora et al. 2010

[a]Sample size in parentheses represents the number of nest sites used to calculate the mean or median hatch date and the number of years used to calculate the long-term average. Current year not included in long-term average.

[b]Mean of annual means.

Productivity.–Ancient murrelet reproductive success was average at Aiktak Island, the only site where this species was monitored in 2009 (Table 20).

Table 20. Reproductive performance of ancient murrelets at Alaskan sites monitored in 2009.

Site	Chicks Fledged/Egg[a]	No. of Plots	Long-term Average	Reference
Aiktak I.	0.82	N/A[b] (209)[c]	0.78 (12)[c]	Sapora et al. 2010

[a]Total chicks fledged/Total eggs.

[b]Not applicable or not reported.

[c]Sample size in parentheses represents the number of eggs used to calculate productivity and the number of years used to calculate the long-term average. Current year not used in long-term average.

Populations.–No data.

Diet.–No data.

Parakeet auklet (*Aethia psittacula*)

Breeding chronology.–Parakeet auklet hatching chronology was early at both monitored sites in 2009 (Table 21, Figure 35).

Table 21. Hatching chronology of parakeet auklets at Alaskan sites monitored in 2009.

Site	Mean	Long-term Average	Reference
Buldir I.	29 Jun (36)[a]	5 Jul[b] (17)[a]	Freeman et al. 2010
Chowiet I.	1 Jul (9)	5 Jul[b] (4)	Andersen et al. 2010

[a]Sample size in parentheses represents the number of nest sites used to calculate the mean or median hatch date and the number of years used to calculate the long-term average. Current year not included in long-term average.

[b]Mean of annual means.

Productivity.–Parakeet auklet productivity was average at Buldir and Chowiet islands, in 2009 (Table 22, Figure 36).

Table 22. Reproductive performance of parakeet auklets at Alaskan sites monitored in 2009.

Site	Chicks Fledged/ Nest Site[a]	No. of Plots	Long-term Average	Reference
Buldir I.	0.59	N/A[b] (70)[c]	0.51 (17)[c]	Freeman et al. 2010
Chowiet I.	0.27	N/A (33)	0.32 (5)	Andersen et al. 2010

[a]Nest site is defined as a site where an egg was laid.

[b]Not applicable or not reported.

[c]Sample size in parentheses represents the number of nest sites used to calculate productivity and the number of years used to calculate the long-term average. Current year not used in long-term average.

Populations.–No data.

Diet.–Parakeet auklets at Buldir Island primarily ate copepods (Figure 37). Euphausiids also were an important prey type in later years. In a small sample from Kasatochi Island, diet consisted entirely of copepods.

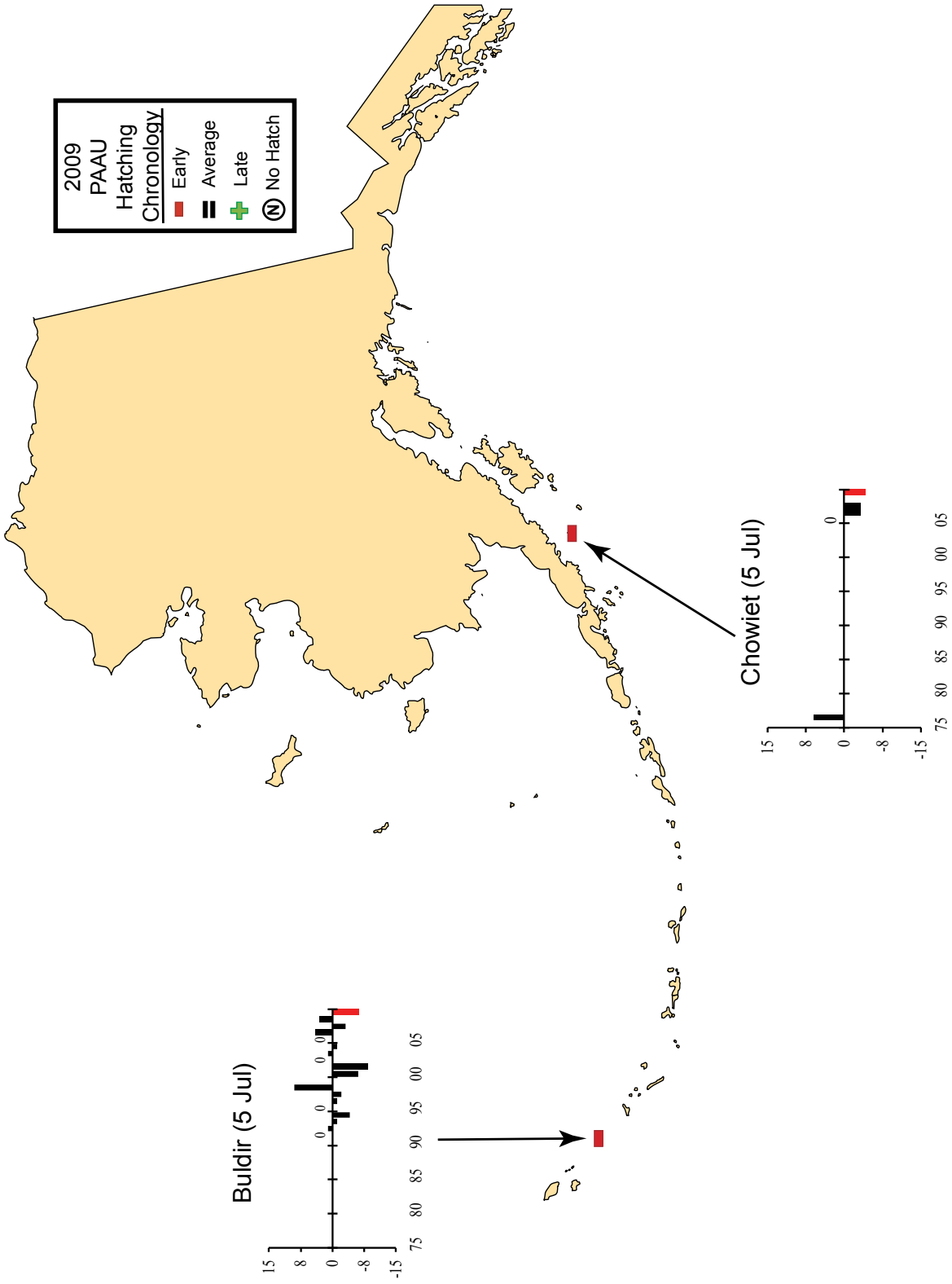


Figure 35. Hatching chronology of parakeet auklets at Alaskan sites. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

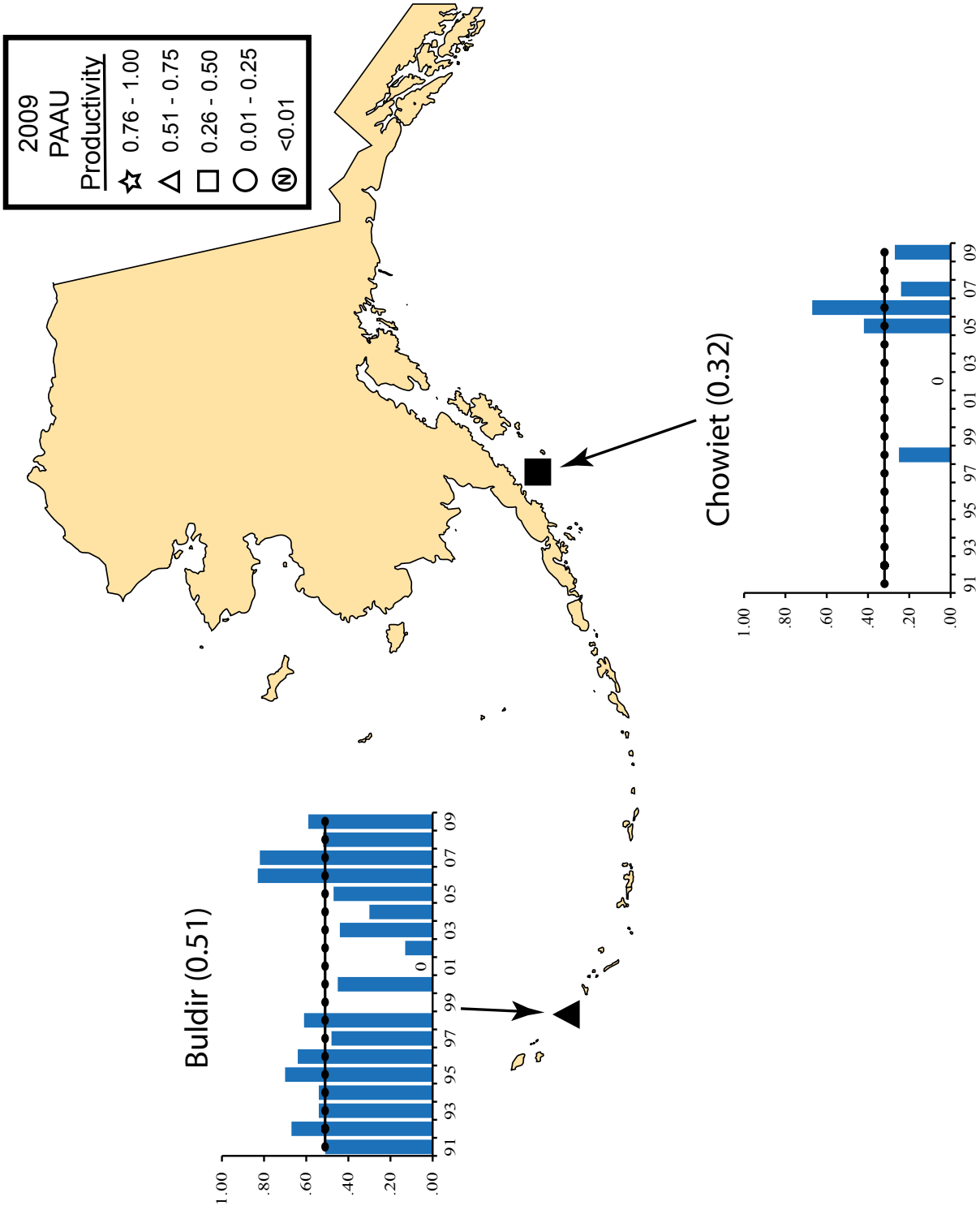
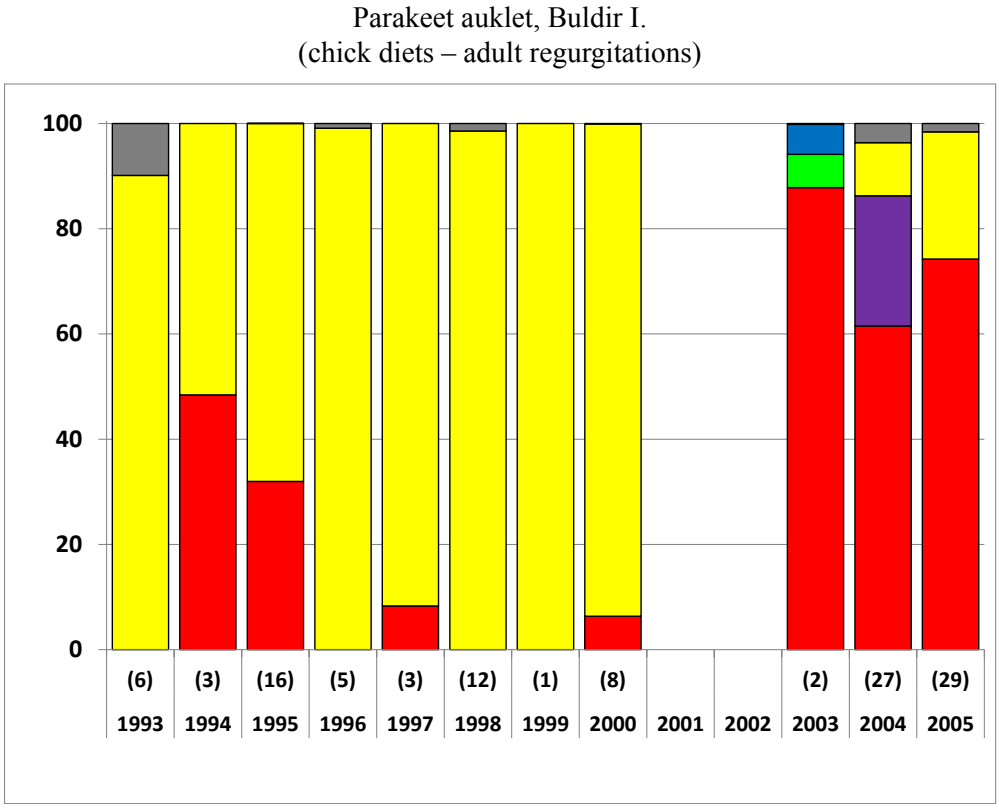


Figure 36. Productivity of parakeet auklets (chicks fledged/nest site) at Alaskan sites. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).



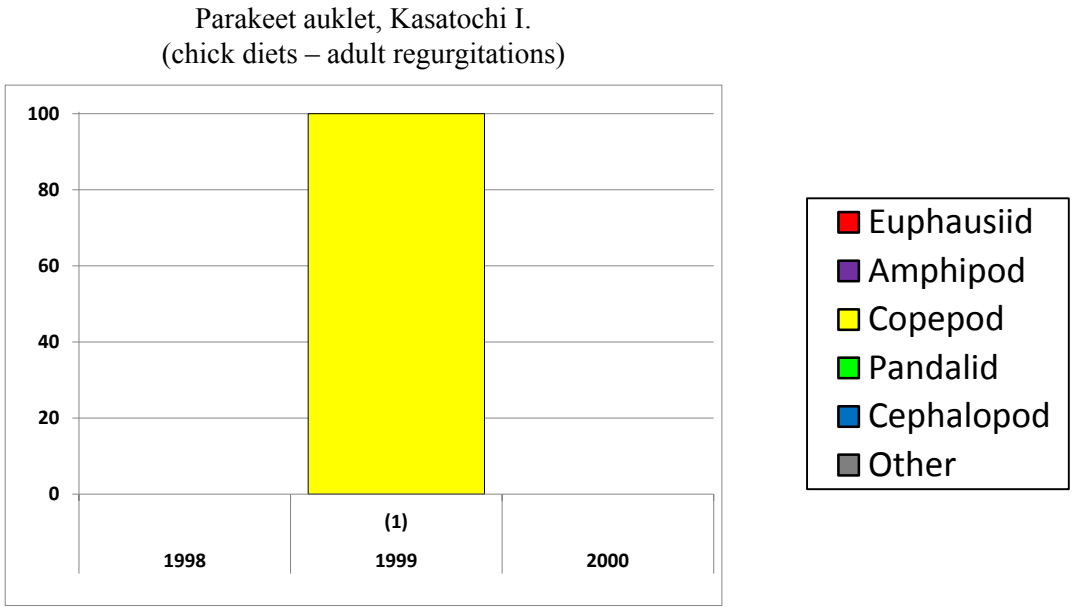


Figure 37. Diets of parakeet auklets at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent biomass of prey type in the diet. Sample sizes are reported below each bar.

Least auklet (*Aethia pusilla*)

Breeding chronology.–The dates of hatching for least auklets were early at St. George Island and average at Buldir and Kiska islands in 2009 (Table 23, Figure 38).

Table 23. Hatching chronology of least auklets at Alaskan sites monitored in 2009.

Site	Mean	Long-term Average	Reference
St. George I.	9 Jul (67)[a]	18 Jul[b] (2)[a]	Shannon et al. 2010
Buldir I.	24 Jun (39)	27 Jun[b] (19)	Freeman et al. 2010
Kiska I.	1 Jul (58)	30 Jun[b] (7)	Bond and Jones 2009

[a]Sample size in parentheses represents the number of nest sites used to calculate the mean or median hatch date and the number of years used to calculate the long-term average. Current year not included in long-term average.

[b]Mean of annual means.

Productivity.–Least auklet reproductive success was average at Kiska Island and above average at Buldir Island in 2009 (Table 24, Figure 39).

Table 24. Reproductive performance of least auklets at Alaskan sites monitored in 2009.

Site	Chicks Fledged/ Nest Site[a]	No. of Plots	Long-term Average	Reference
St. George I.	0.77	N/A[b] (75)[c]	N/A	Shannon et al. 2010
Buldir I.	0.74	N/A (85)	0.55 (19)[c]	Freeman et al. 2010
Kiska I.	0.44	3 (164)	0.43 (7)	Bond and Jones 2009

[a]Nest site is defined as a site where an egg was laid.

[b]Not applicable or not reported.

[c]Sample size in parentheses represents the number of nest sites used to calculate productivity and the number of years used to calculate the long-term average. Current year not used in long-term average.

Populations.–We found no population trends for least auklets at St. George Island during all years and an increase between 2000 and 2009 (Figure 40). Auklet numbers declined during both time periods at Kasatochi Island.

Diet.–Diet samples from least auklets at St. Lawrence Island consisted mostly of copepods (Figure 41). Least auklets at St. Paul Island showed a yearly variation in diet; copepods dominated in some years, while euphausiids were equally or more important in other years. Diet samples from St. George, Buldir, Kiska, Kasatochi, Gareloi and Semisopochnoi islands consisted primarily of copepods.

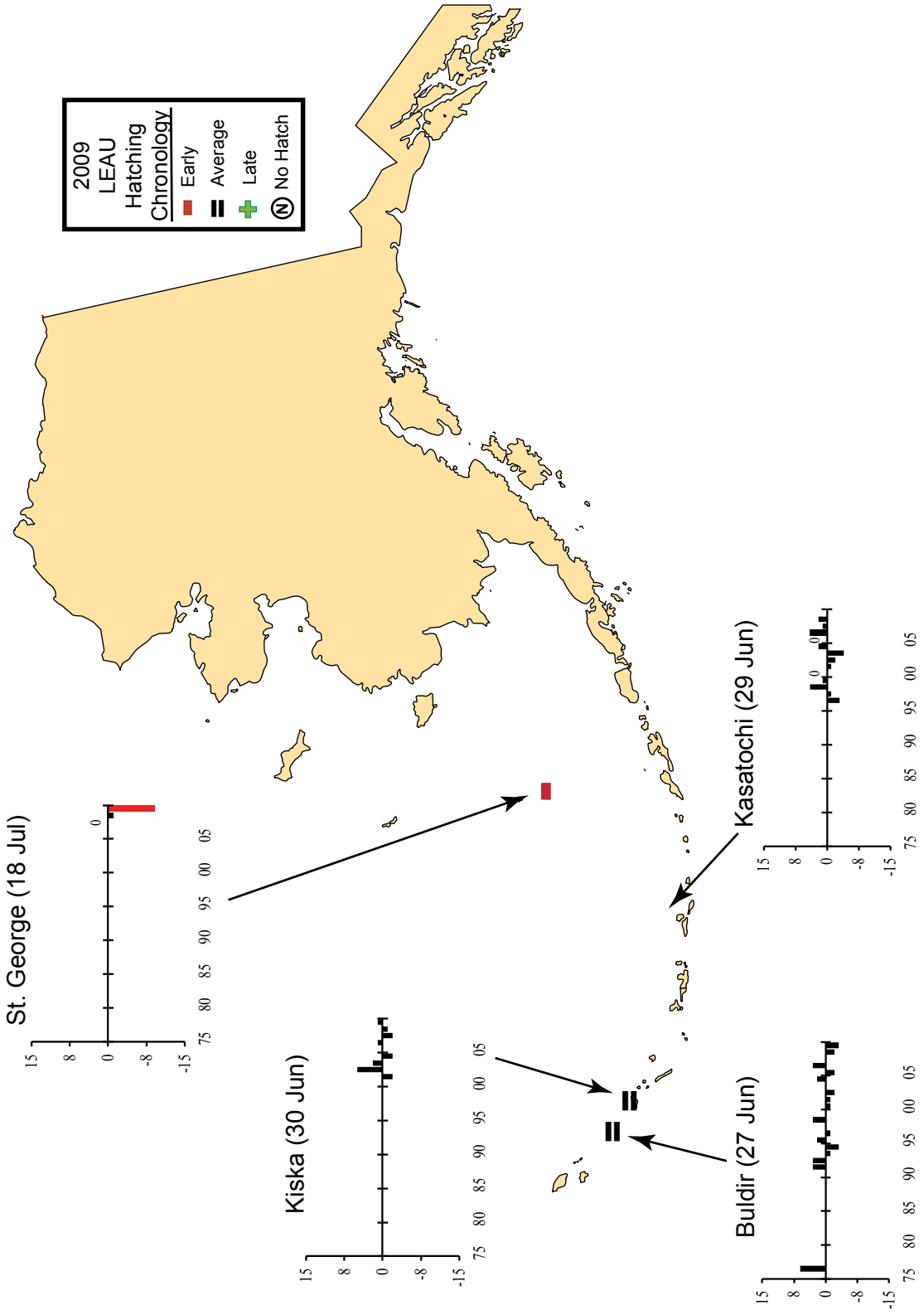


Figure 38. Hatching chronology of least auklets at Alaskan sites. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

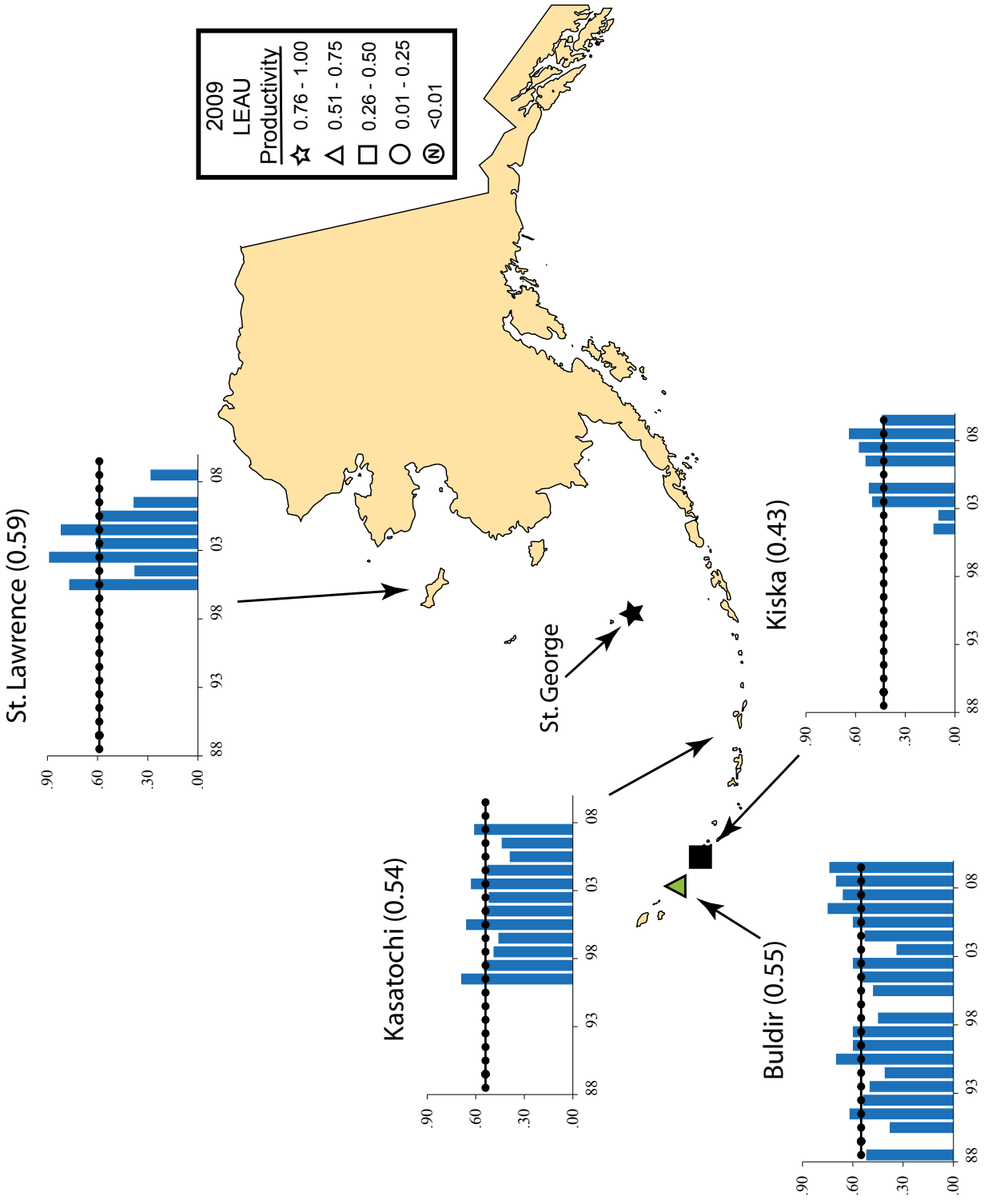


Figure 39. Productivity of least auklets (chicks fledged/nest site) at Alaskan sites. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

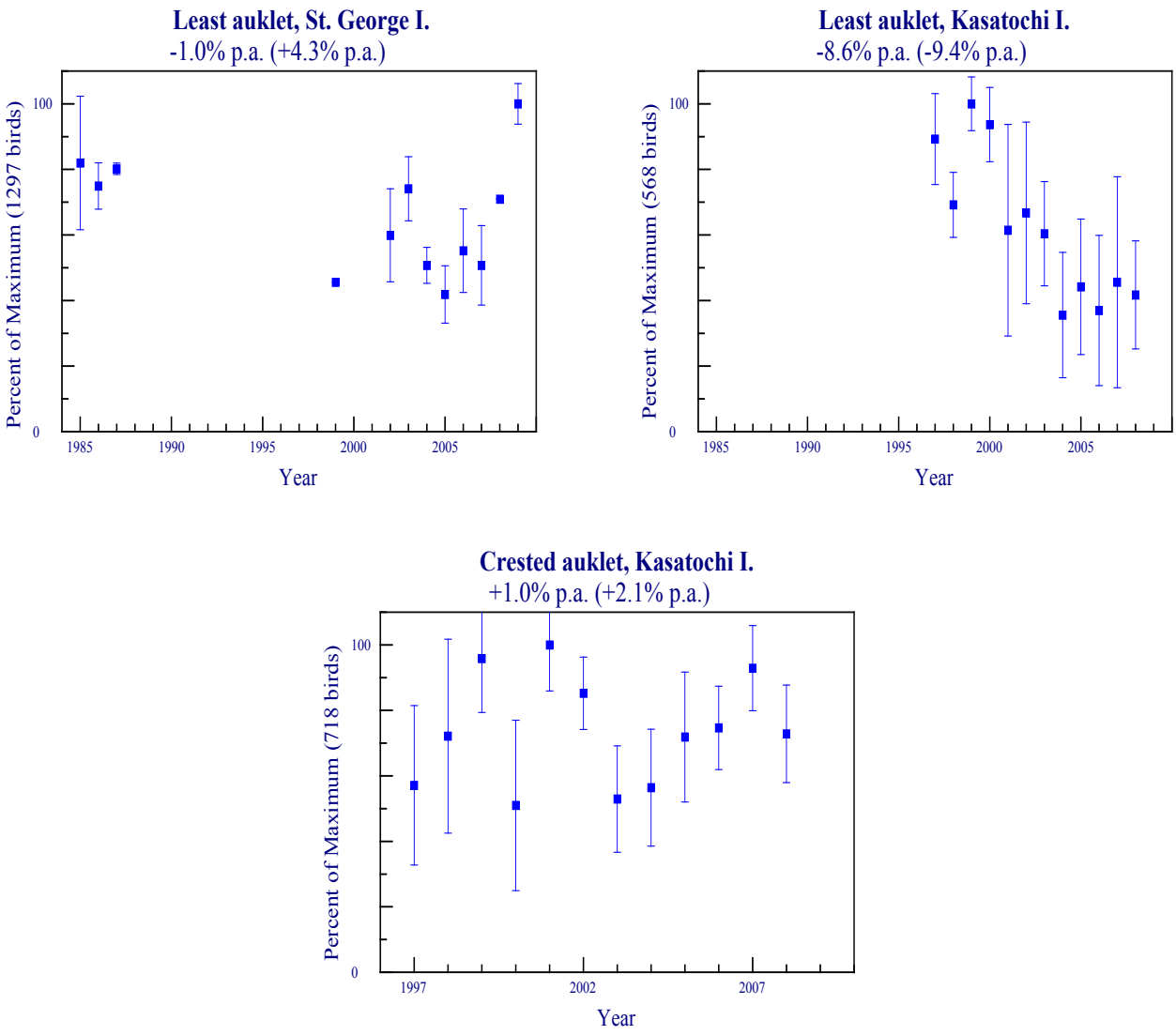


Figure 40. Trends in populations of least (top) and crested (bottom) auklets at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (2000-2009, in parentheses).

Figure 41. Diets of least auklets at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent biomass of prey type in the diet. Sample sizes are reported below each bar.

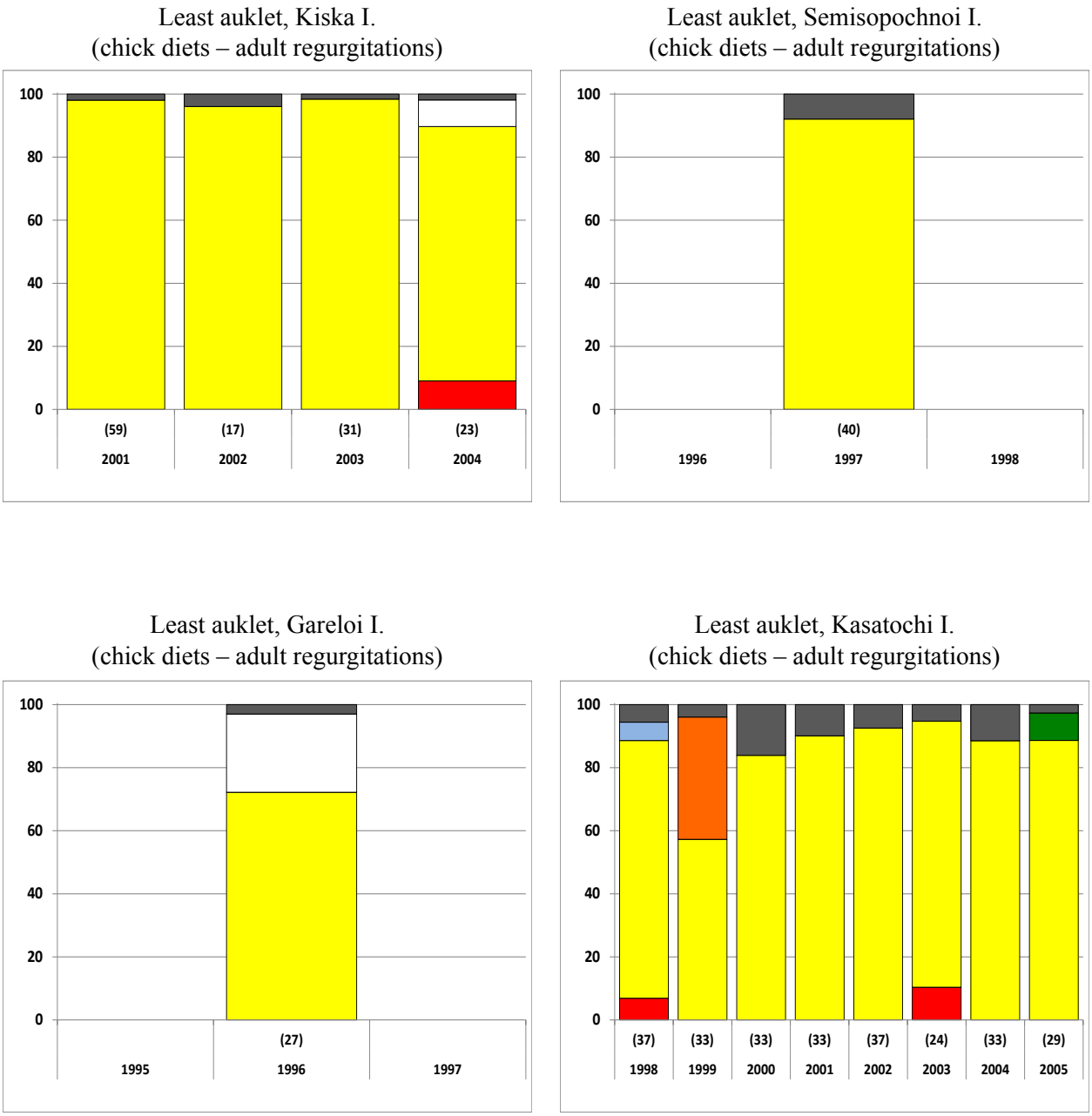


Figure 41 (continued). Diets of least auklets at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent biomass of prey type in the diet. Sample sizes are reported below each bar.

Whiskered auklet (*Aethia pygmaea*)

Breeding chronology.–The mean hatching date for whiskered auklets was earlier than average at Buldir Island in 2009 (Table 25).

Table 25. Hatching chronology of whiskered auklets at Alaskan sites monitored in 2009.

Site	Mean	Long-term Average	Reference
Buldir I.	17 Jun (62)	23 Jun[b] (19)[a]	Freeman et al. 2010

[a] Sample size in parentheses represents the number of nest sites used to calculate the mean or median hatch date and the number of years used to calculate the long-term average. Current year not included in long-term average.

[b] Mean of annual means.

Productivity.–Productivity of whiskered auklets was above average at Buldir Island in 2009 (Table 26).

Table 26. Reproductive performance of whiskered auklets at Alaskan sites monitored in 2009.

Site	Chicks Fledged/ Nest Site[a]	No. of Plots	Long-term Average	Reference
Buldir I.	0.82	N/A[b] (94)[c]	0.61 (18)[c]	Freeman et al. 2010

[a]Nest site is defined as a site where an egg was laid.

[b]Not applicable or not reported.

[c]Sample size in parentheses represents the number of nest sites used to calculate productivity and the number of years used to calculate the long-term average. Current year not used in long-term average.

Populations.–No data.

Diet.–Diet samples from whiskered auklets at Buldir Island were dominated in most years by copepods, although in several years euphausiids were the dominant prey type. Least auklets at Egg Island ate predominately copepods (Figure 42).

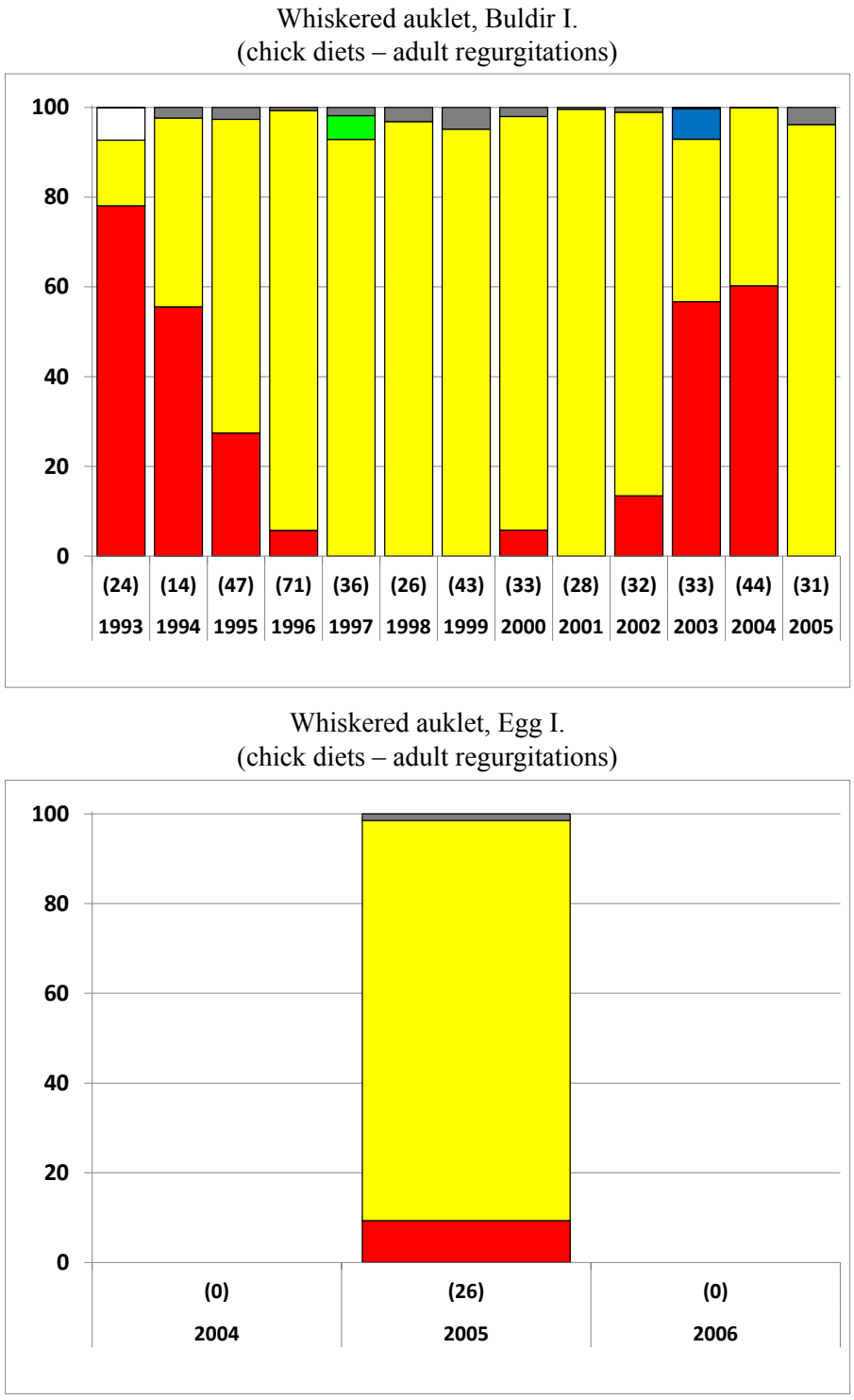


Figure 42. Diets of whiskered auklets at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent biomass of prey type in the diet. Sample sizes are reported below each bar.

Crested auklet (*Aethia cristatella*)

Breeding chronology.–The mean date of hatching for crested auklets was early at Buldir and Kiska islands in 2009. (Table 27, Figure 43).

Table 27. Hatching chronology of crested auklets at Alaskan sites monitored in 2009.

Site	Median	Mean	Long-term Average	Reference
Buldir I.	—	25 Jun (49)[a]	29 Jun[b] (19)[a]	Freeman et al. 2010
Kiska I.	—	27 June (9)	2 Jul[b] (5)	Bond and Jones 2009

[a]Sample size in parentheses represents the number of nest sites used to calculate the mean or median hatch date and the number of years used to calculate the long-term average. Current year not included in long-term average.

[b]Mean of annual means

Productivity.–Crested auklets exhibited average productivity at Kiska Island and above average success at Buldir Island 2009 (Table 28, Figure 44).

Table 28. Reproductive performance of crested auklets at Alaskan sites monitored in 2009.

Site	Chicks Fledged/ Nest Site[a]	No. of Plots	Long-term Average	Reference
Buldir I.	0.87	N/A[b] (103)[c]	0.64 (19)[c]	Freeman et al. 2010
Kiska I.	0.52	3 (23)	0.57 (7)	Bond and Jones 2009

[a]Nest site is defined as a site where an egg was laid.

[b]Not applicable or not reported.

[c]Sample size in parentheses represents the number of nest sites used to calculate productivity and the number of years used to calculate the long-term average. Current year not used in long-term average.

Populations.–We found no population trends for crested auklets at Kasatochi Island either for all years or between 2000 and 2009 (Figure 40).

Diet.–Crested auklets at St. Lawrence and Kiska islands primarily ate euphausiids (Figure 45). Samples from Buldir and Kasatochi islands contained a high biomass of copepods; euphausiids were also a major prey source at Buldir Island in some years.

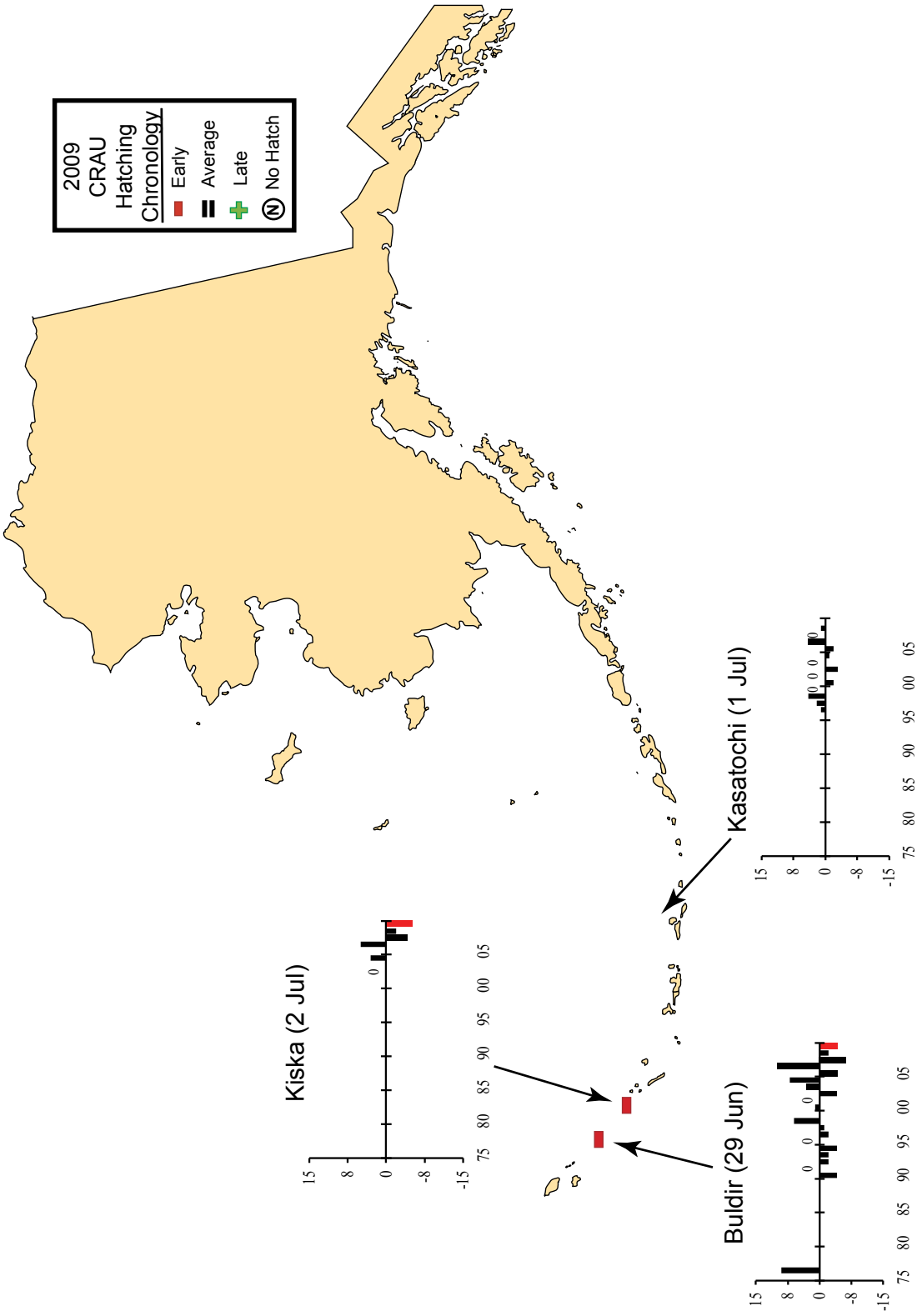


Figure 43. Hatching chronology of crested auklets at Alaskan. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

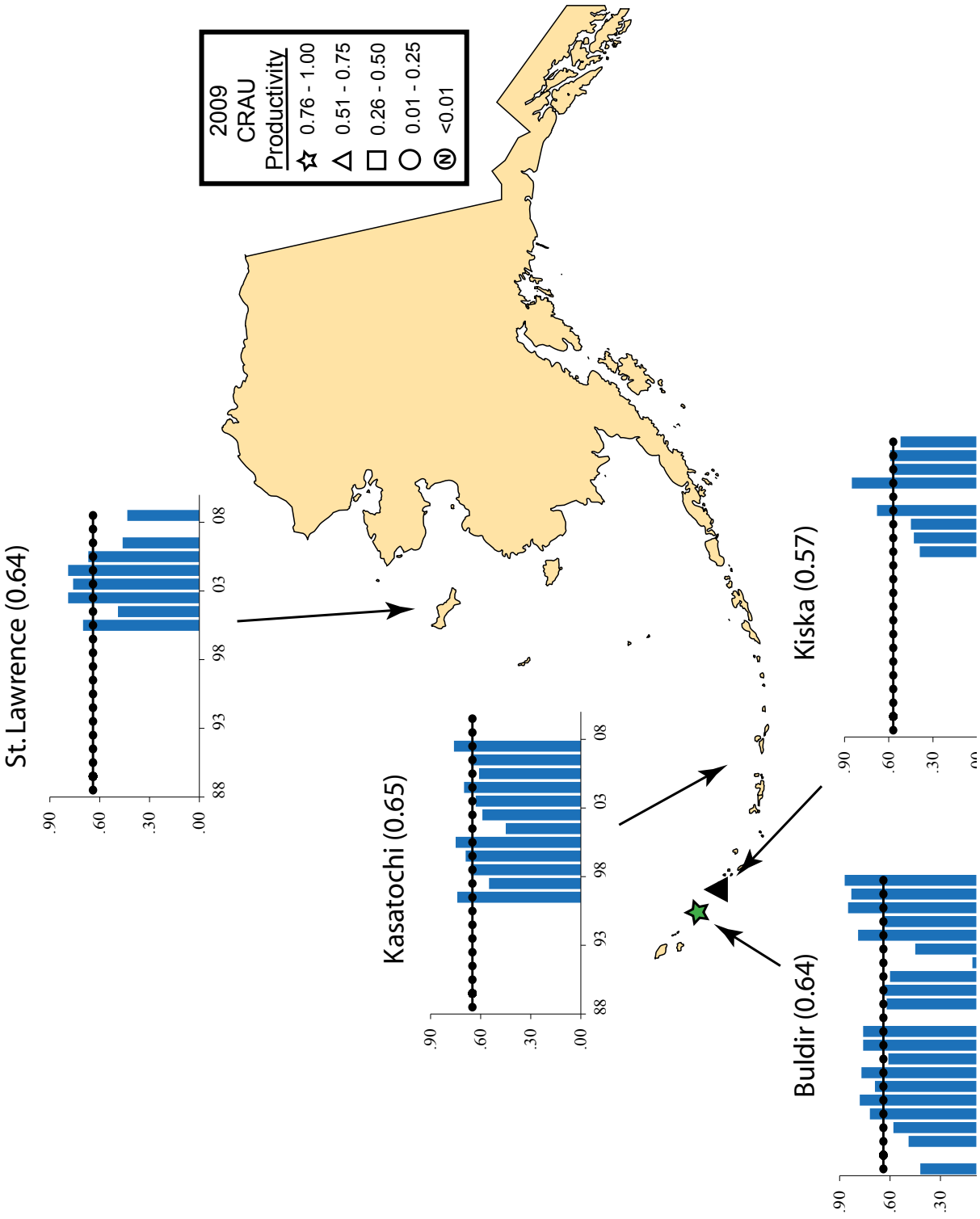


Figure 44. Productivity of crested auklets (chicks fledged/nest site) at Alaskan sites. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

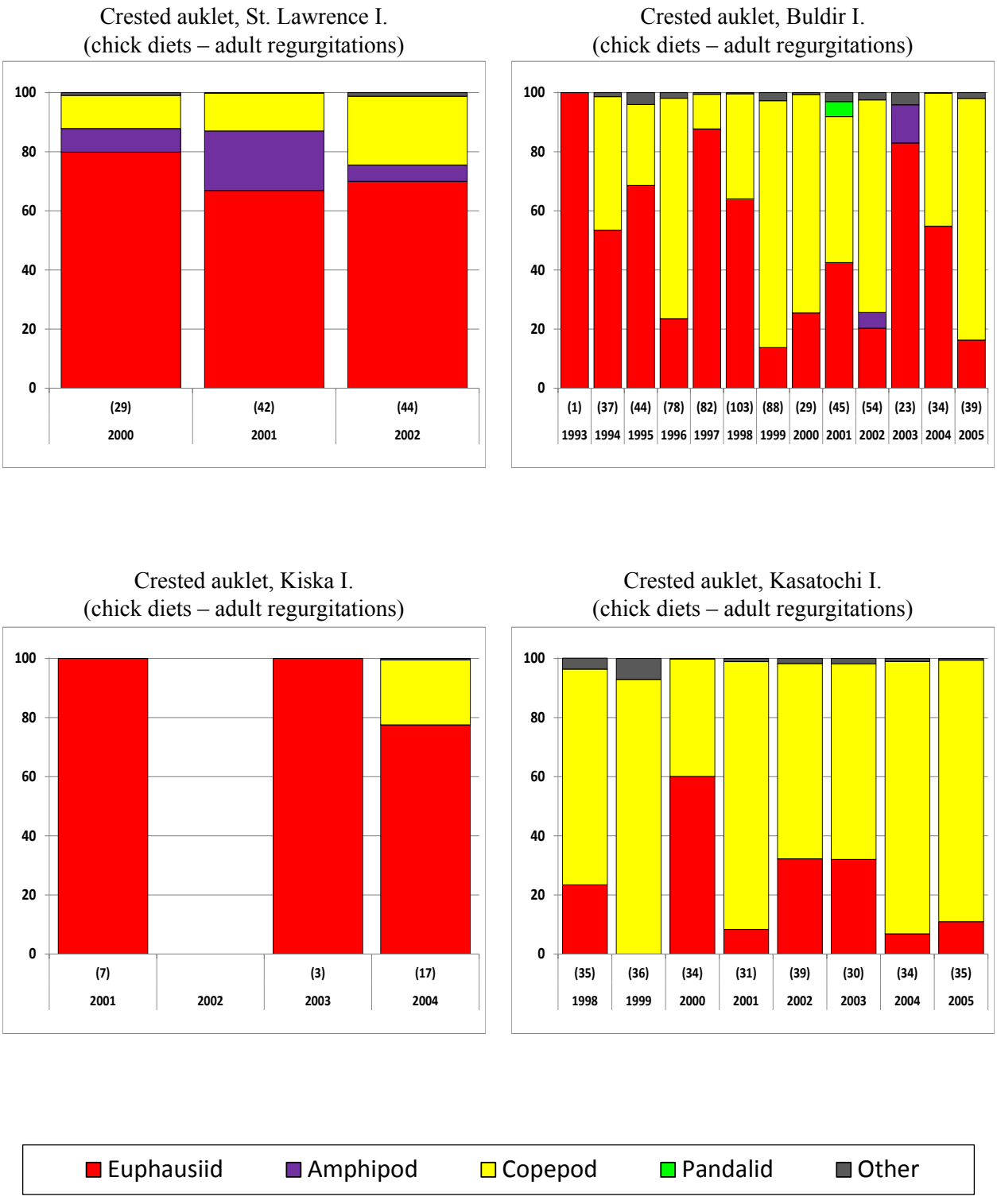


Figure 45. Diets of crested auklets at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent biomass of prey type in the diet. Sample sizes are reported below each bar.

Rhinoceros auklet (*Cerorhinca monocerata*)

Breeding chronology.–No data in 2009.

Productivity.–Productivity was above average at St. Lazaria Island in 2009 (Table 29).

Table 29. Reproductive performance of rhinoceros auklets at Alaskan sites monitored in 2009.

Site	Chicks Fledged/Egg	No. of Plots	Long-term Average	Reference
St. Lazaria I.	0.91	N/A[a] (N/A)[b]	0.52 (15)[b]	L. Slater Unpubl. Data

[a]Not applicable or not reported.

[b]Sample size in parentheses represents the number of eggs used to calculate productivity and the number of years used to calculate the long-term average. Current year not used in long-term average.

Populations.–We found positive trends in populations of rhinoceros auklets at St. Lazaria Island for all years as well as between 2000 and 2009 (Figure 46).

Diet.–Diets collected from rhinoceros auklets at Chowiet and Middleton islands were dominated by sand lance (Figure 47). Rhinoceros auklets from St. Lazaria Island ate primarily sand lance, capelin, and herring, with other small fish making up most of the rest of the diet.

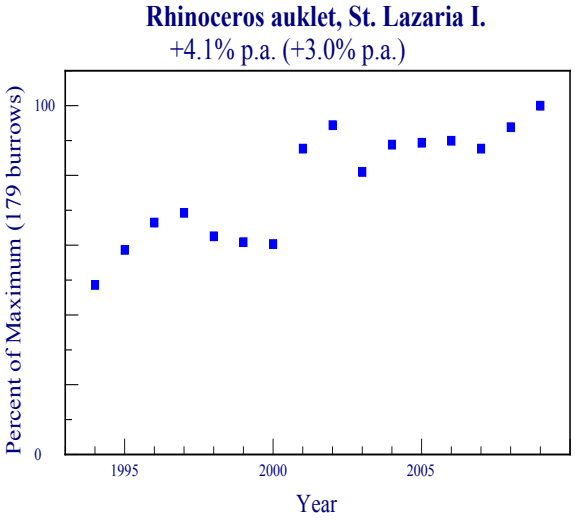


Figure 46. Trends in populations of rhinoceros auklets at Alaskan sites. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (2000-2009, in parentheses).

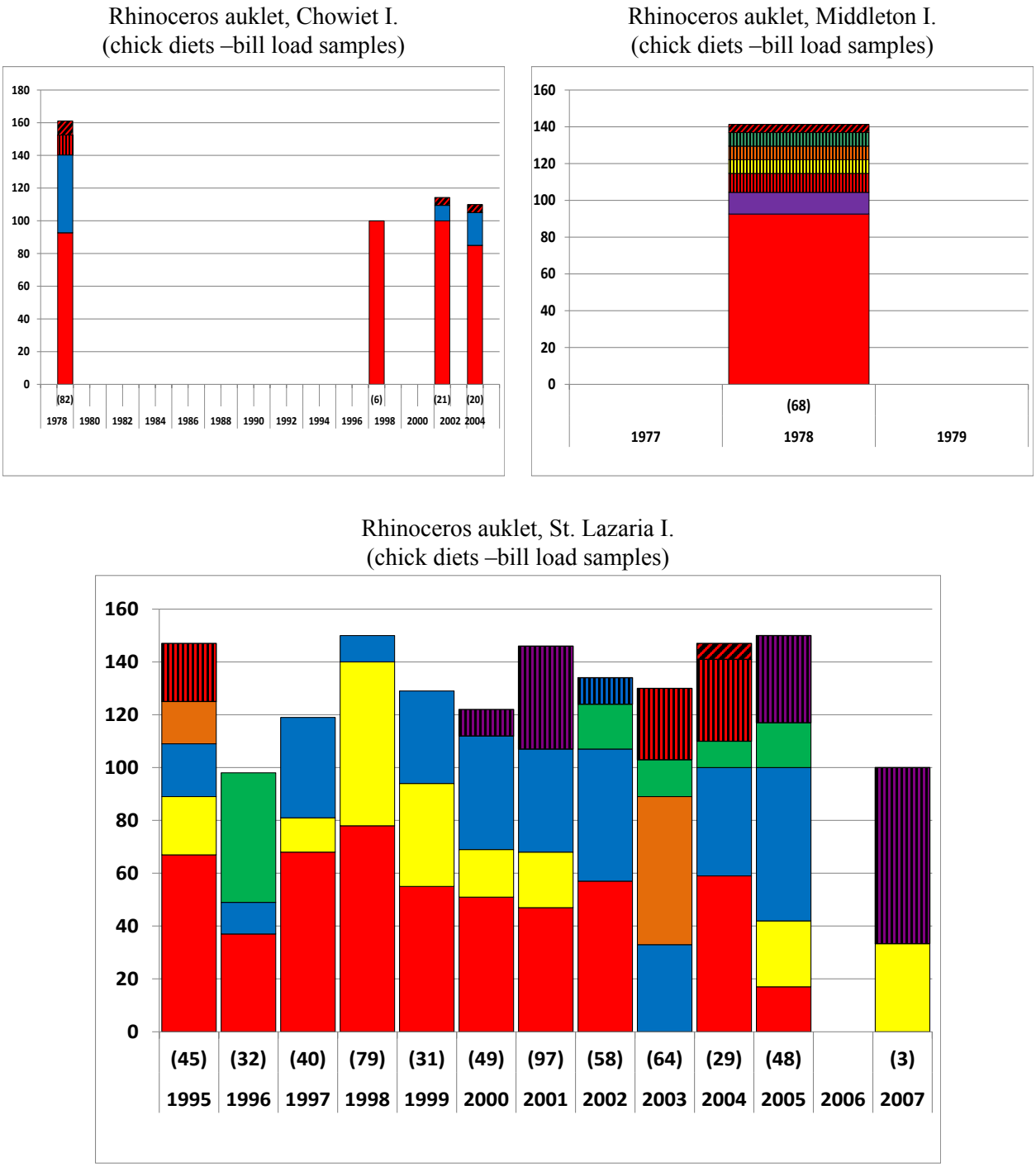


Figure 47. Diets of rhinoceros auklets at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Horned puffin (*Fratercula corniculata*)

Breeding chronology.–Horned puffin breeding chronology was late at Buldir Island, and average at Aiktak and Chowiet islands in 2009 (Table 30, Figure 48).

Table 30. Hatching chronology of horned puffins at Alaskan sites monitored in 2009.

Site	Mean	Long-term Average	Reference
Buldir I.	29 Jul (26)[a]	24 Jul[b] (21)[a]	Freeman et al. 2010
Aiktak I.	1 Aug (14)	2 Aug[b] (7)	Sapora et al. 2010
Chowiet I.	30 Jul (16)	31 Jul[b] (5)	Andersen et al. 2010

[a]Sample size in parentheses represents the number of nest sites used to calculate the mean or median hatch date and the number of years used to calculate the long-term average. Current year not included in long-term average.
[b]Mean of annual means.

Productivity.–Horned puffins exhibited above average productivity at Aiktak Island, average success at Chowiet Island and below average productivity at Buldir Island in 2009 (Table 31, Figure 49).

Table 31. Reproductive performance of horned puffins at Alaskan sites monitored in 2009.

Site	Chicks Fledged/Egg	No. of Plots	Long-term Average	Reference
Buldir I.	0.30	N/A[a] (46)[b]	0.44 (21)[b]	Freeman et al. 2010
Aiktak I.	0.71	N/A (20)	0.52 (7)	Sapora et al. 2010
Chowiet I.	0.30	N/A (40)	0.37 (5)	Andersen et al. 2010

[a]Not applicable or not reported.
[b]Sample size in parentheses represents the number of eggs used to calculate productivity and the number of years used to calculate the long-term average. Current year not used in long-term average.

Populations.–No data.

Diet.–Diets collected from a small sample of horned puffins from Cape Lisburne contained small fish (Figure 50). Horned puffins at Buldir Island ate primarily greenling and sand lance; small fish and squid also occurred in the diet samples. Small sample sizes from Aiktak Island show a varied diet; sand lance and pollock were major contributors in some years, along with various other small fish and invertebrates. Horned puffins at the Semidi Islands ate predominately sand lance.

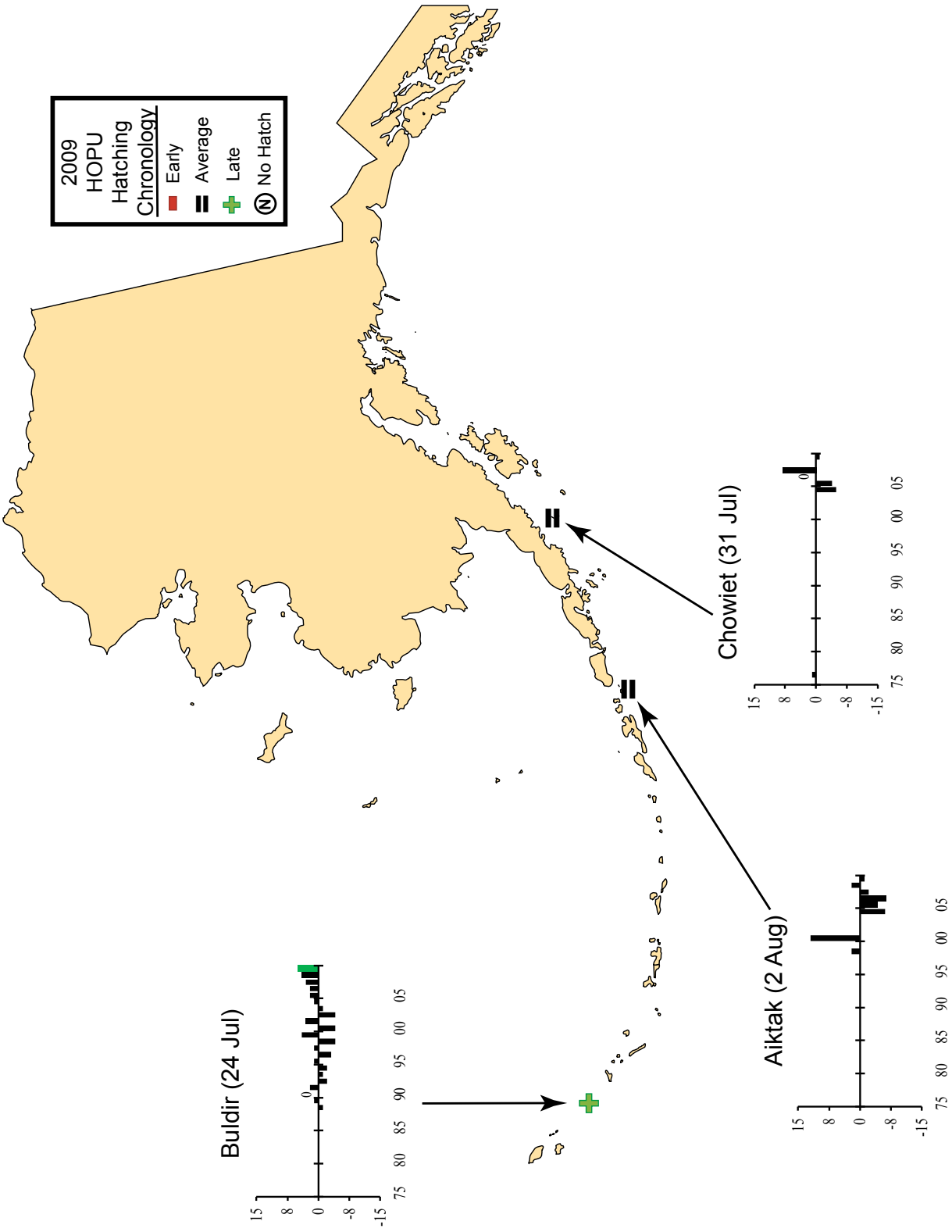


Figure 48. Hatching chronology of horned puffins at Alaskan sites. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

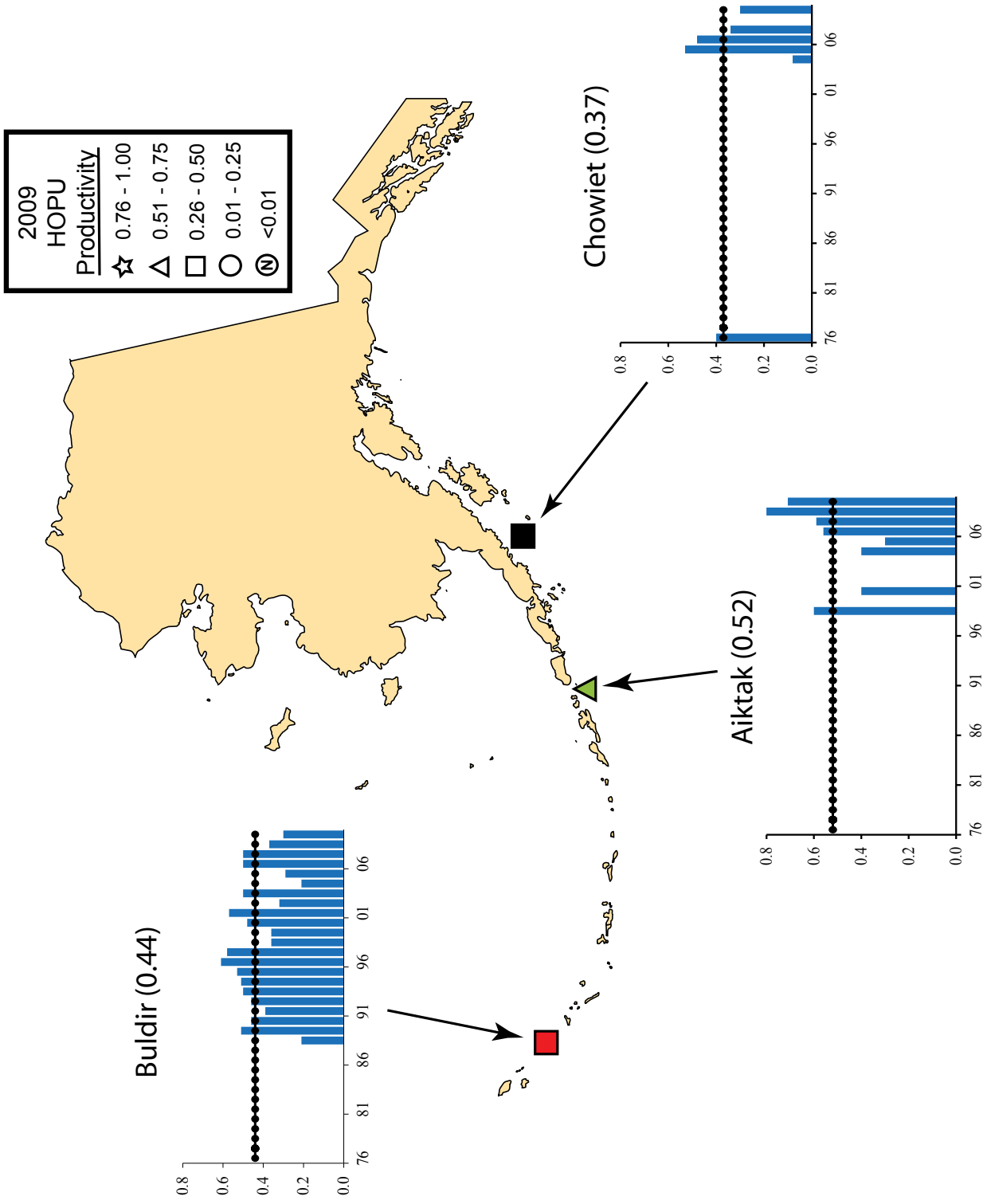


Figure 49. Productivity of horned puffins (chicks fledged/egg) at Alaskan sites. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

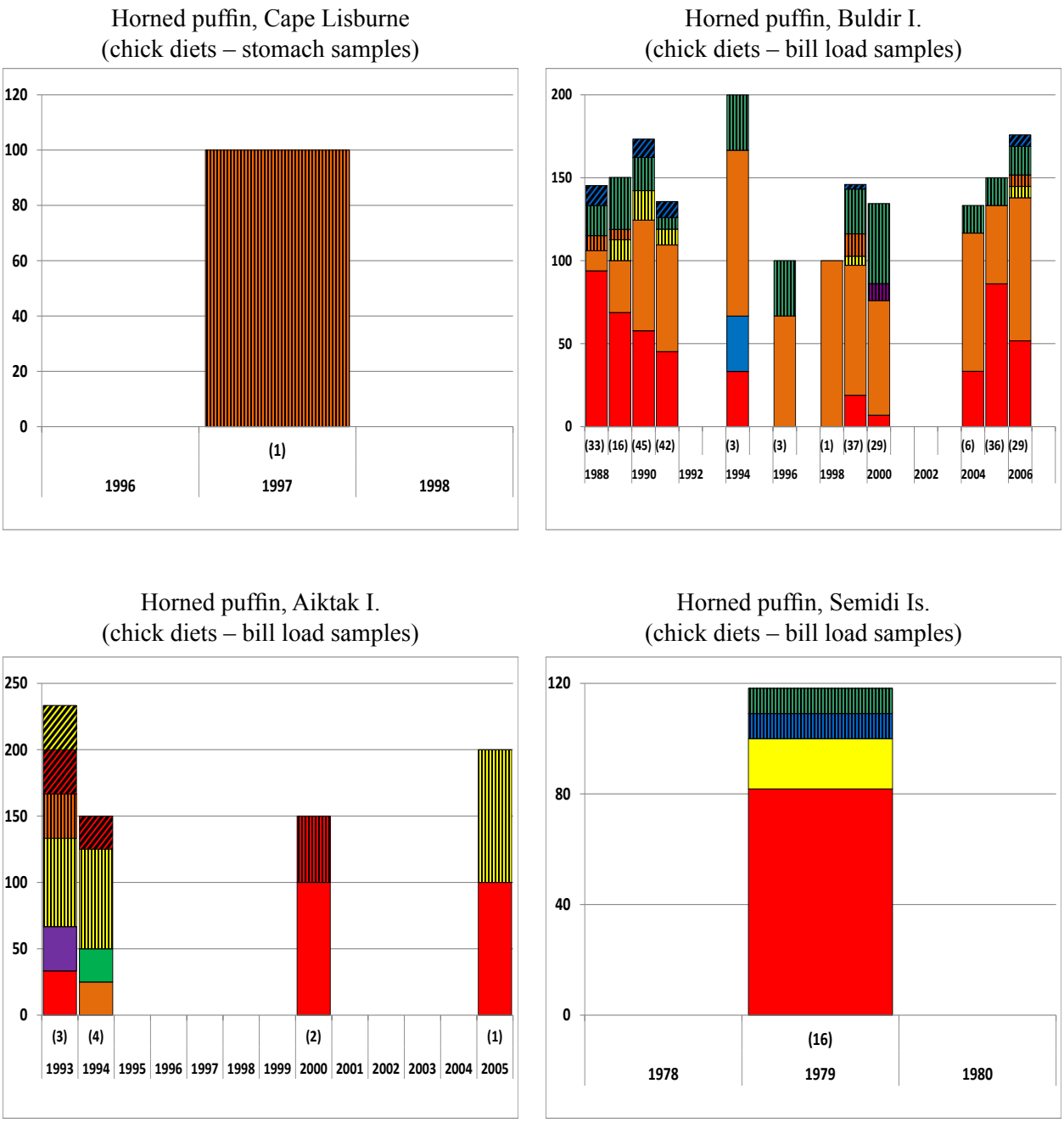


Figure 50. Diets of horned puffins at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Tufted puffin (*Fratercula cirrhata*)

Breeding chronology.–Hatch dates for tufted puffins were early at Aiktak Island, average at Chowiet Island and late at Buldir Island in 2009 (Table 32, Figure 51).

Table 32. Hatching chronology of tufted puffins at Alaskan sites monitored in 2009.

Site	Mean	Long-term Average	Reference
Buldir I.	27 Jul (8)[a]	15 Jul[b] (19)[a]	Freeman et al. 2010
Aiktak I.	26 Jul (53)	3 Aug[b] (12)	Sapora et al. 2010
Chowiet I.	24 Jul (22)	23 Jul[b] (4)	Andersen et al. 2010

[a]Sample size in parentheses represents the number of nest sites used to calculate the mean or median hatch date and the number of years used to calculate the long-term average. Current year not included in long-term average.

[b]Mean of annual means.

Productivity.–In 2009, tufted puffin productivity was above average at Aiktak Island, average at Chowiet Island and below average at Buldir Island (Table 33, Figure 52).

Table 33. Reproductive performance of tufted puffins at Alaskan sites monitored in 2009.

Site	Chicks Fledged[a]/Egg	No. of Plots	Long-term Average	Reference
Buldir I.	0.21	N/A[b] (27)[c]	0.44 (21)[c]	Freeman et al. 2010
Aiktak I.	0.84	N/A (97)	0.49 (13)	Sapora et al. 2010
Chowiet I.	0.39	N/A (43)	0.36 (4)	Andersen et al. 2010

[a]Fledged chick defined as being still alive at last check in August or September.

[b]Not applicable or not reported.

[c]Sample size in parentheses represents the number of eggs used to calculate productivity and the number of years used to calculate the long-term average. Current year not used in long-term average.

Populations.–No trends were evident for tufted puffin populations either for all years or between 2000 and 2009 at Aiktak Island (Figure 53). Puffin burrow numbers declined during both time periods at East Amatuli Island. A negative trend for all years at St. Lazaria Island has stabilized in recent years.

Diet.–Diet samples from Buldir Island showed a diverse diet; greenling, pollock and squid were important prey items in most years, while sand lance and pollock were significant sources of food in some years (Figure 54). Samples from Aiktak Island showed diversity; pollock was an important contributor in most years. Sand lance and other small fish also were of varying importance there. Tufted puffins from the Barren Islands ate solely small fish; pollock were a major contributor. Tufted puffins from Middleton Island ate predominately sand lance and small cephalopods.

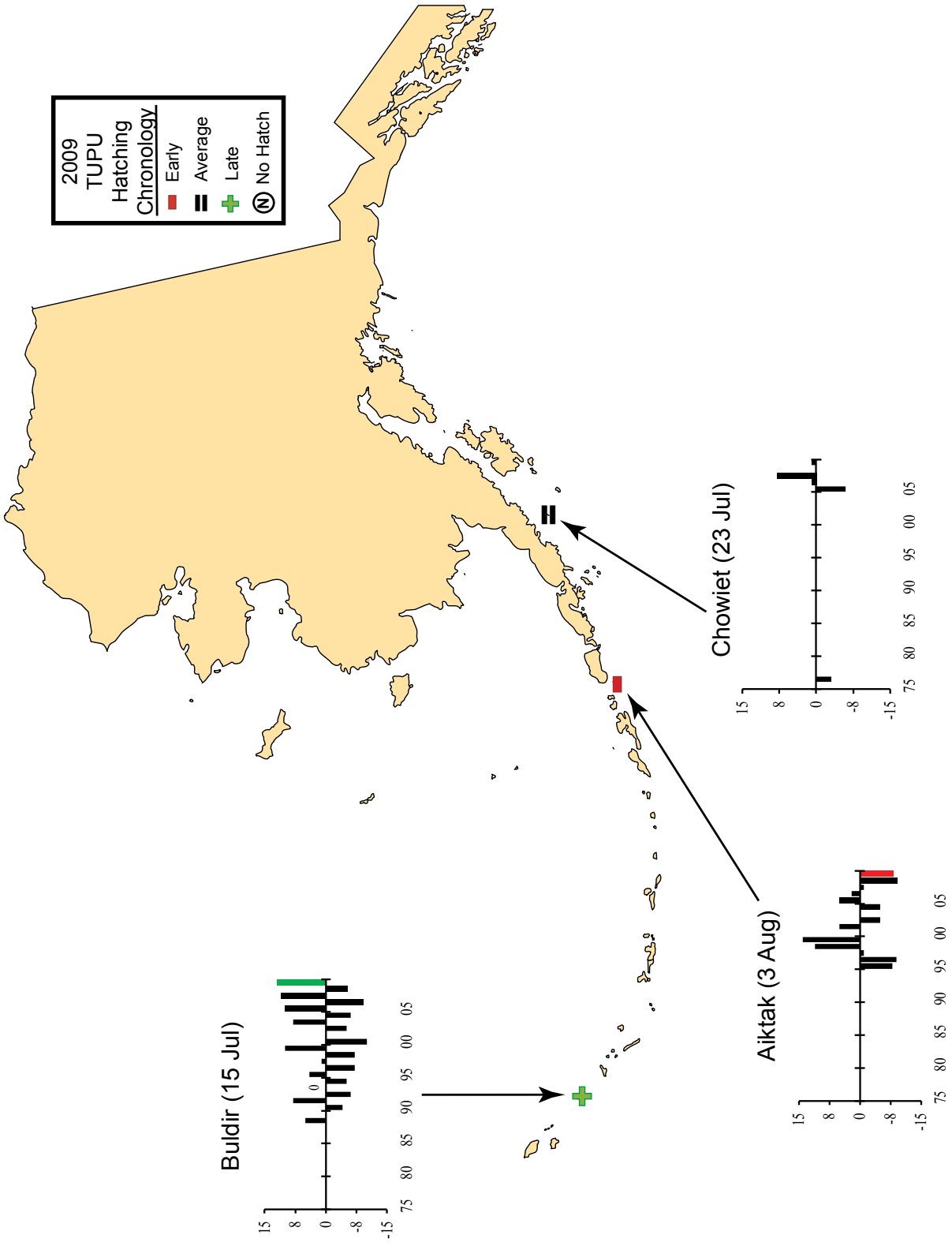


Figure 51. Hatching chronology of tufted puffins at Alaskan sites. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

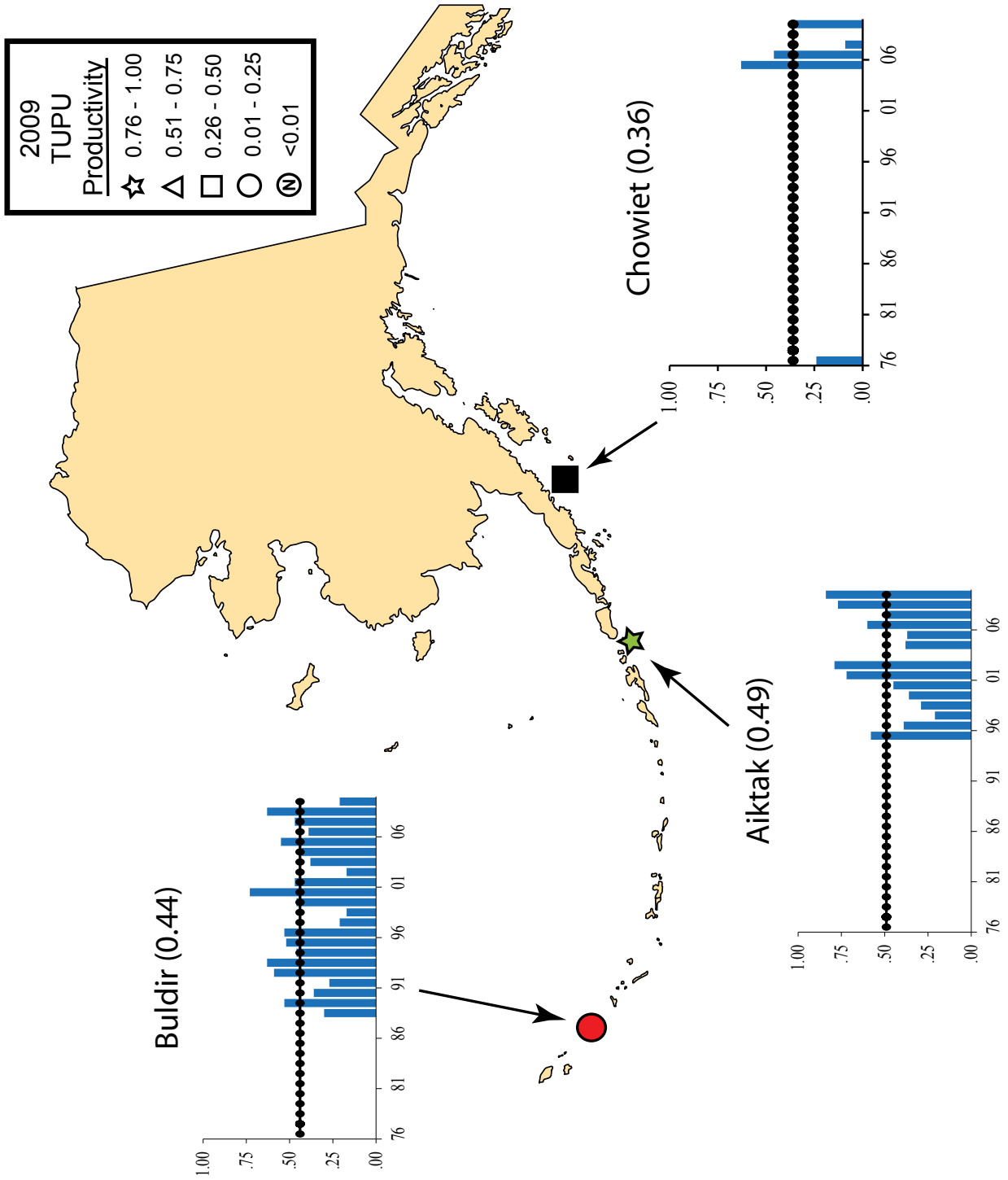


Figure 52. Productivity of tufted puffins (chicks fledged/egg) at Alaskan sites. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

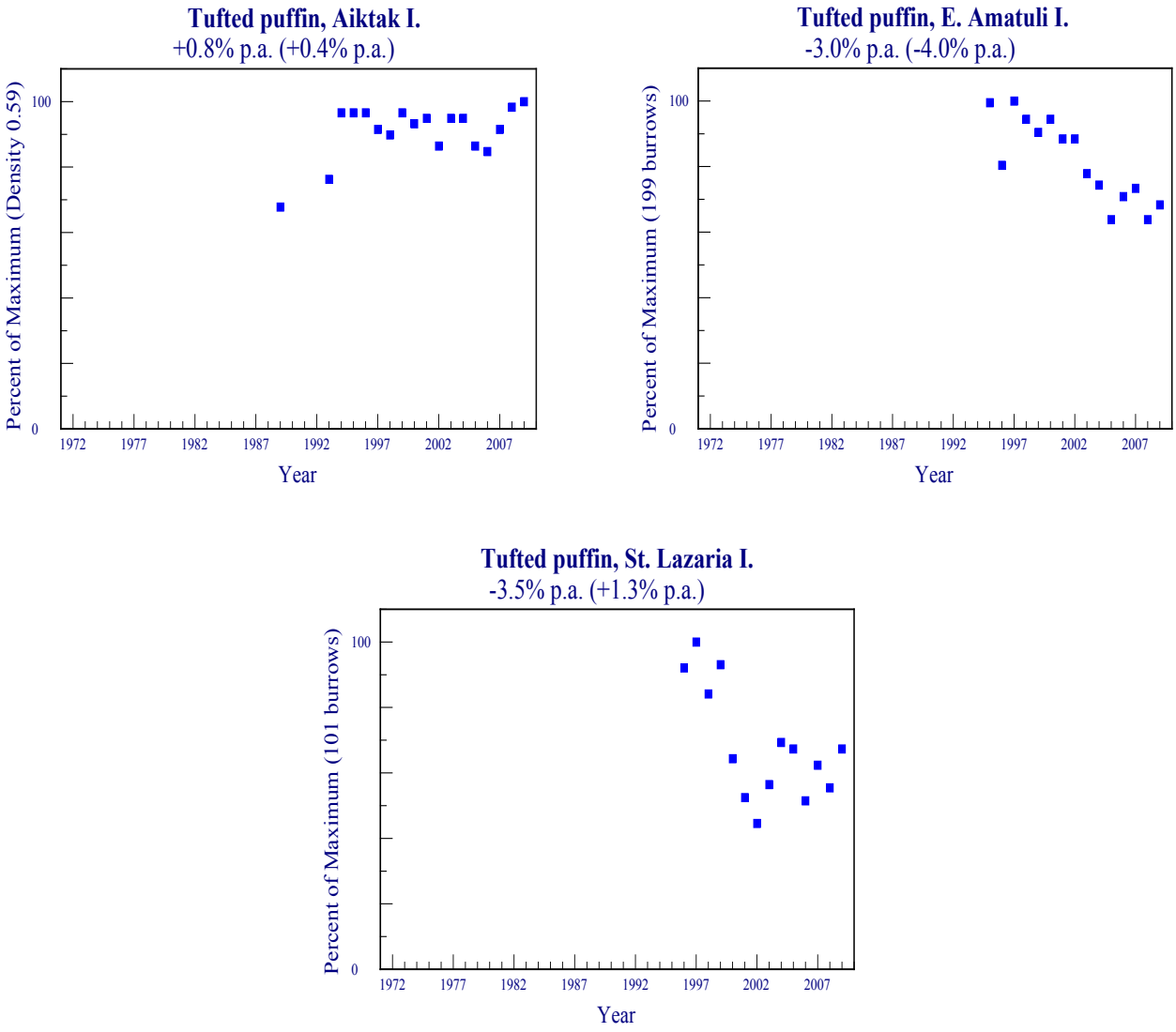


Figure 53. Trends in populations of tufted puffins at Alaskan sites. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (2000-2009, in parentheses).

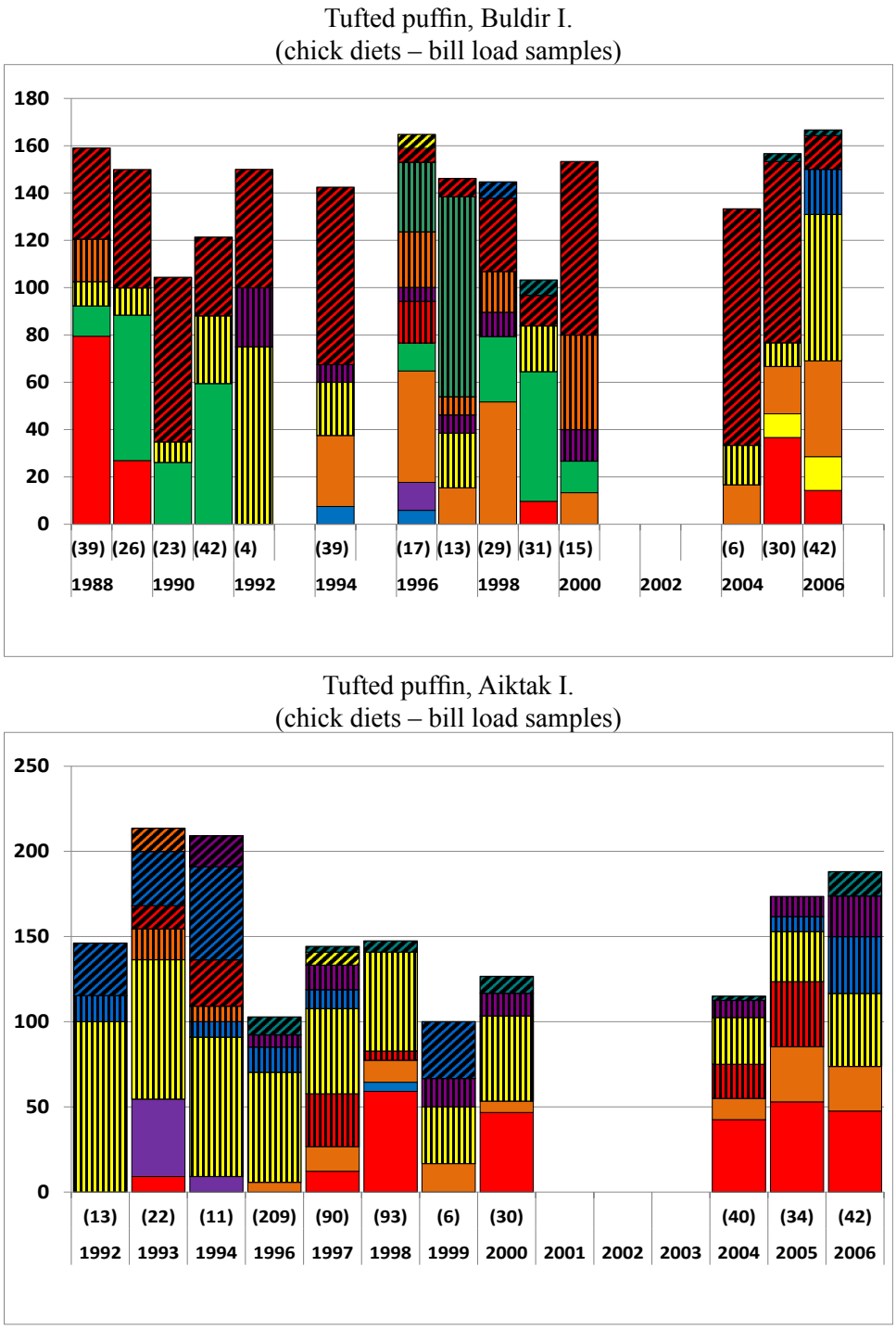


Figure 54. Diets of tufted puffins at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

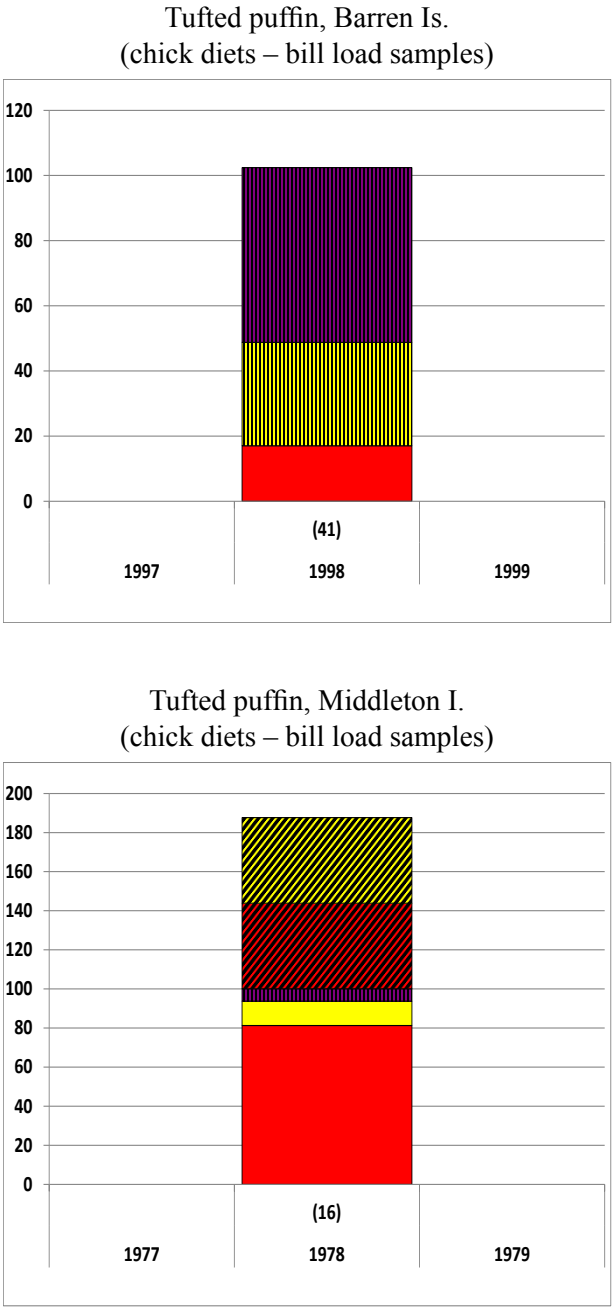


Figure 54 (continued). Diets of tufted puffins at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Summary

Species differences

Surface plankton-feeders.–In 2009, timing of hatching was early or average for fork-tailed (FTSP) and Leach's (LHSP) storm-petrels at Aiktak and St. Lazaria islands (Table 34). Storm-petrels had average reproductive success at all monitored sites in 2009, except that fork-tailed storm-petrel productivity was lower than average at Buldir Island and high at St. Lazaria Island (Table 35). Fork-tailed storm-petrel burrow counts remained stable both in the long term and between 2000 and 2009 at East Amatuli Island (Table 36). Storm-petrel (STPE) counts (species combined) increased at Aiktak Island and remained stable at St. Lazaria Island during both time periods.

Surface fish-feeders.–We found no trends for northern fulmar (NOFU) populations at any monitored colony when all years were included. Just considering the last decade (2000-2009), we found that fulmar populations declined at the Pribilof Islands and Chowiet Island (Table 36).

Black-legged kittiwake (BLKI) hatch dates were earlier than normal at three of four monitored locations in 2009 (Table 34). In 2009, black-legged kittiwake productivity was below average at six (75%) of the eight monitored sites and above average at two colonies (Table 35). For all years, black-legged kittiwake populations exhibited declines at three colonies (25%), no trends at seven sites (58%) and positive trends at two locations (17%,Table 36). Between 2000 and 2009, populations declined at three colonies (28%), exhibited no trend at four sites (36%) and increased at four locations (36%).

Red-legged kittiwake (RLKI) hatching chronology was early at St. Paul and St. George islands, and late at Buldir Island in 2009 (Table 34). Reproductive success was below average at St. George Island, average at St. Paul Island and above average at Buldir Island in 2009 (Table 35). In all years, this species exhibited a negative population trend at St. Paul Island and no trend at either St. George Island or Buldir Island (Table 36). Between 2000 and 2009, the decline continued at St. Paul Island and populations remained stable at Buldir and St. George islands.

Glaucous-winged gulls (GWGU) are treated here, although they are opportunistic feeders taking other birds as well as fish for prey. In 2009, gull mean hatch date was early at St. Lazaria Island, average at Aiktak and Chowiet islands, and late at Buldir Island (Table 34). Gulls had below average success at Aiktak Island, average productivity at Chowiet and St. Lazaria islands, and above average success at Buldir Island in 2009 (Table 35). Glaucous-winged gull populations showed a decline at Buldir Island, no trends at three colonies (50%), and increases at Middleton and St. Lazaria islands when all years were included (Table 36). Between 2000 and 2009, gull populations continued to decline at Buldir Island, became stable at Middleton Island and increased at three sites (60%).

Diving fish-feeders (nearshore).–Timing of hatching was average for red-faced cormorants (RFCO) at St. Paul Island in 2009 (Table 34). Red-faced cormorants had below average productivity at St. George Island, and average success at St. Paul and Buldir islands in 2009 (Table 35). Pelagic cormorant (PECO) success was below average at Cape Peirce and Aiktak Island, average at Round Island, and above average at Buldir and St. Lazaria islands in

Table 34. Seabird relative breeding chronology[a] compared to averages for past years. Only sites for which there were data from 2009 are included.

Region	Site	FTSP[b]	LHSP	RFCO	BLKI	RLKI	GWGU	COMU	TBMU	ANMU	PAAU	LEAU	WHAU	CRAU	HOPU	TUPU
SE Bering	St. Paul I.			↔	↓	↓		↓	↓							
	St. George I.				↓	↓		↓	↓			↓				
	Aiktak I.	↔	↔				↔			↔					↔	↓
SW Bering	Buldir I.				↑	↑	↑		↑		↓	↔	↓	↓	↑	↑
	Kiska I.											↔		↓		
Gulf of Alaska	Chowiet I.				↓		↔	↔	↔		↓				↔	↔
	E. Amatuli I.							↑								
Southeast	St. Lazaria I.	↓	↔				↓	↔	↔							

[a] Codes:
↓ and red cell color indicate hatching chronology was > 3 days earlier than the average for this site.
↔ and yellow cell color indicate hatching chronology was within 3 days of average.
↑ and green cell color indicate hatching chronology was > 3 days later than the average for this site.
[b]FTSP=fork-tailed storm-petrel, LHSP=Leach's storm-petrel, RFCO=red-faced cormorant, BLKI=black-legged kittiwake, RLKI=red-legged kittiwake, GWGU=glaucous-winged gull, COMU=common murre, TBMU=thick-billed murre, ANMU=ancient murrelet, PAAU=parakeet auklet, LEAU=least auklet, WHAU=whiskered auklet, CRAU=crested auklet, HOPU=horned puffin, TUPU=tufted puffin.

Table 35. Seabird relative productivity levels[a] compared to averages for past years. Only sites for which there were data from 2009 are included.

Region	Site	FTSP[b]	LHSP	RFCO	PECO	BLKI	RLKI	GWGU	COMU	TBMU	ANMU	PAAU	LEAU	WHAU	CRAU	RHAU	HOPU	TUPU
N. Bering/ Chukchi	C. Lisburne					↓												
SE Bering	St. Paul I.			↔		↓	↔		↔	↔								
	St. George I.			↓		↓	↓		↔	↔			↔					
	C. Peirce				↓	↑												
	Round I.				↔	↓			↓									
	Aiktak I.	↔	↔		↓			↓	↓	↓	↔						↑	↑
SW Bering	Buldir I.	↓	↔	↔	↑	↑	↑	↑		↔		↔	↑	↑	↑		↓	↓
	Kiska I.												↔		↔			
Gulf of Alaska	Chowiet I.					↓		↔	↔	↔		↔					↔	↔
	E. Amatuli I.					↓												
Southeast	St. Lazaria I.	↑	↔		↑			↔	↔	↔						↑		

[a] Codes:
↓ and red cell color indicate productivity was > 20% below the average for this site.
↔ and yellow cell color indicate productivity was within 20% of average.
↑ and green cell color indicate productivity was > 20% above the average for this site.
[b]FTSP=fork-tailed storm-petrel, LHSP=Leach's storm-petrel, RFCO=red-faced cormorant, PECO=pelagic cormorant, BLKI=black-legged kittiwake, RLKI=red-legged kittiwake, GWGU=glaucous-winged gull, COMU=common murre, TBMU=thick-billed murre, ANMU=ancient murrelet, PAAU=parakeet auklet, LEAU=least auklet, WHAU=whiskered auklet, CRAU=crested auklet, RHAU=rhinoceros auklet, HOPU=horned puffin, TUPU=tufted puffin.

Table 36. Seabird population trends[a] for all available years ("A" columns), and the past decade (2000-2009, "D" columns).

Region	Site	NOFU[b]		FTSP		STPE		PECO		UNCO		BLKI		RLKI		GWGU		COMU		TBMU		UNMU		PIGU		LEAU		CRAU		RHAU		TUPU	
		A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D
N. Bering/ Chukchi	C. Lisburne											↑	↑									↑	↔										
	Bluff											↔	↔					↔	↔														
	Hall I.	↔	N/A					↔	N/A			↓	N/A					↔	N/A	↓	N/A												
SE Bering	St. Paul I.	↔	↓									↔	↑	↓	↓			↓	↓	↔	↔												
	St. George I.	↔	↓									↔	↔	↔	↔			↔	↓	↔	↔					↔	↑						
	C. Peirce							↔	↓			↓	↓					↔	↔														
	Round I.											↔	↔					↑	↑														
	Bogoslof I.															↔	N/A																
	Aiktak I.					↑	↑			↔	↔					↔	↑					↓	↑									↔	↔
SW Bering	Buldir I.							↑	↔			↑	↓	↔	↔	↓	↓			↑	↑			↔	↓								
	Ulak I.									↓	↓											↑	↑										
	Kasatochi I.									↔	↓					↔	↑							↔	N/A	↓	↓	↔	↔				
	Koniuji I											↔	↑									↑	↓										
Gulf of Alaska	Chowiet I.	↔	↓									↔	↑									↔	↑										
	E. Amatuli I.			↔	↔																											↓	↓
	P. William Snd											↔	↔											↓	N/A								
	Middleton I.							↓	↔			↓	↓			↑	↔					↓	↔										
Southeast	St. Lazaria I.					↔	↔	↑	↓							↑	↑					↔	↔	↔	↔					↑	↑	↓	↔

[a] Codes:
↓ and red cell color indicate a negative population trend of ≥3% per annum for this site.
↔ and yellow cell color indicate no population trend.
↑ and green cell color indicate a positive population trend of ≥3% per annum for this site.
"N/A" indicates that there were insufficient data to determine a trend (see Methods).

[b]NOFU=northern fulmar, FTSP=fork-tailed storm-petrel, STPE=storm-petrel, PECO=pelagic cormorant, UNCO= unspecified cormorant, BLKI=black-legged kittiwake, RLKI=red-legged kittiwake, GWGU=glaucous-winged gull, COMU=common murre, TBMU=thick-billed murre, UNMU=unspecified murre, PIGU=pigeon guillemot, LEAU=least auklet, CRAU=crested auklet, RHAU=rhinoceros auklet, TUPU=tufted puffin.

2009. When all years were included, pelagic cormorants showed negative trends at Middleton Island, and stable numbers or increases at two sites each (Table 36). Between 2000 and 2009, pelagic cormorants declined at two sites and remained stable at two colonies. Over all years, unidentified cormorant (UNCO) populations were stable at two of the three monitored colonies, and declined at Ulak Island. Unidentified cormorant numbers declined at two colonies and exhibited no trend at Aiktak Island between 2000 and 2009.

Overall, pigeon guillemot (PIGU) numbers showed a decline in Prince William Sound, but no trends at Buldir, Kasatochi or St. Lazaria islands (Table 36). Between 2000 and 2009, this species declined at Buldir Island and remained stable at St. Lazaria Island.

Diving fish-feeders (offshore).–Timing of common murre (COMU) hatching in 2009 was early at two sites, average at two colonies and late at one site (Table 34). Thick-billed murre (TBMU) chronology was early at two sites, average at two colonies and late at one location in 2009.

Common and thick-billed murres exhibited average or below average reproductive success at all monitored sites in 2009 (Table 35).

In all years, numbers of common murres showed a decline at St. Paul Island, remained stable at four locations (67%) and increased at Round Island (Table 36). Common murre numbers exhibited declines at St. Paul and St. George islands, no trends at two sites and an increase at Round Island between 2000 and 2009. Overall, thick-billed murre populations exhibited a declining trend at Hall Island, an increase at Buldir Island and stable numbers at two locations. Thick-billed murre numbers remained stable in recent years at the Pribilof Islands, and continued to increase at Buldir Island. At colonies where murres were not identified to species during counts (UNMU), numbers increased or remained stable at five sites and showed negative trends at two locations in all years (Table 36). Unspecified murre populations declined at Koniuji Island, showed no trends at three colonies and increased at three locations between 2000 and 2009.

Ancient murrelet (ANMU) hatching chronology and productivity were average at Aiktak Island in 2009 (Tables 34 and 35).

Rhinoceros auklet (RHAU) productivity was above average at St. Lazaria Island in 2009 (Table 35). We found an increase in the number of rhinoceros auklet burrows at St. Lazaria Island, both overall and between 2000 and 2009 (Table 36).

Horned puffins (HOPU) exhibited normal or late hatching chronology at all three monitored sites in 2009 (Table 34). Horned puffin breeding success was lower than average at Buldir Island, average at Chowiet Island and higher than average at Aiktak Island in 2009 (Table 35).

Tufted puffin (TUPU) eggs hatched earlier than average at Aiktak Island, at about the normal time at Chowiet Island and late at Buldir Island in 2009 (Table 34). Reproductive success for this species was lower than average at Buldir Island, average at Chowiet Island and high at Aiktak Island in 2009 (Table 35). Tufted puffin populations declined at E. Amatuli and St. Lazaria islands, and showed no trend at Aiktak Island in all years (Table 36). Between 2000 and 2009, tufted puffin numbers were stable at two sites and continued to decline at East Amatuli Island.

Diving plankton-feeders.–Parakeet (PAAU), least (LEAU), whiskered (WHAU) and crested (CRAU) auklets had earlier than average hatching chronologies for the most part in 2009, the exceptions being the average timing of least auklets at Buldir and Kiska islands (Table 34). Parakeet, least, whiskered and crested auklets had average or above average success at all monitored sites in 2009 (Table 35). Least auklet populations declined at Kasatochi Island and were stable at St. George Island during all years. Least auklet numbers declined at Kasatochi Island and increased at St. George Island between 2000 and 2009. Crested auklet numbers were stable during both time periods at Kasatochi Island (Table 36).

Regional differences

Northern Bering/Chukchi.–Reproductive success was below average for black-legged kittiwakes at Cape Lisburne, the only colony and species for which productivity data were gathered in this region in 2009 (Table 35).

When all years were considered, we found declining trends in 22% of cases (two of nine; species x site) in this region, stable populations in 56% of instances (five of nine) and increases for 22% of the species monitored at Cape Lisburne (Table 36). There were insufficient data to determine recent trends at Hall Island. Seventy-five percent of instances (three of four) with adequate recent data showed stable populations between 2000 and 2009, and an increase in black-legged kittiwake numbers at Cape Lisburne during that decade (Table 36).

Southeastern Bering.–Fork-tailed and Leach's storm-petrel, and red-faced cormorant hatching chronology was average in this region in 2009 (Table 34). Both species of kittiwake exhibited early hatching in this region and glaucous-winged gull chronology was average. Common and thick-billed murres were early at the Pribilof Islands in 2009. Ancient murrelet hatching was average at Aiktak Island and least auklets hatched earlier than average at St. George Island. Horned puffin hatching chronology was average at Aiktak Island in 2009, whereas tufted puffin chicks hatched early there.

Storm-petrel reproductive success was average in this region in 2009 (Table 35). Cormorants experienced average or below average productivity region wide. Kittiwakes and gulls exhibited lower than normal productivity in 75% of instances (six of eight) in this region in 2009, and average or above average productivity at two sites. Murre productivity was average or below average at all monitored colonies in the region. Ancient murrelets and least auklets exhibited average productivity in the region, and puffin success was above average at Aiktak Island in 2009.

When all years were considered, we found negative population trends in 18% of cases (four of 22; species x site), stable populations in 73% of instances (16 of 22) and increases in two cases (9%, Table 36). Between 2000 and 2009, breeding seabird populations declined in 33% of instances (seven of 21), were stable in 38% of cases (eight of 21) and exhibited increasing trends in 29% of instances (six of 21) in this region.

Southwestern Bering.–Kittiwake, gull, thick-billed murre and puffin hatching was later than average at Buldir Island in 2009 (Table 34). Plankton-feeders (auklets) exhibited earlier than average breeding chronology in 67% of instances (four of six) in this region in 2009, and average

timing in two cases.

Storm-petrels exhibited average or below average productivity in this region in 2009 (Table 35). Cormorant success was average or above average. Black- and red-legged kittiwakes, and glaucous-winged gulls had above average productivity at Buldir Island, and thick-billed murre productivity was average there. Auklets exhibited average or above average productivity at monitored colonies in this region in 2009, whereas puffin success was below average.

When all years were considered, we found negative population trends in 20% of the cases (three of 15; species x site), stable populations in 47% of instances (seven of 15) and increases in 33% of cases (five of 15, Table 36). Breeding seabird populations declined in 50% of instances (seven of 14), were stable in 21% of cases (three of 14) and exhibited increasing trends in 29% of instances (four of 14) in this region between 2000 and 2009.

Northern Gulf of Alaska.–Breeding chronology was early for black-legged kittiwakes and average for gulls breeding in this region in 2009 (Table 34). Murre timing was average at Chowiet Island and late at E. Amatuli Island. Parakeet auklets hatched early at Chowiet Island and puffin timing was average there in 2009.

Black-legged kittiwake productivity was below average in the region in 2009 (Table 35). Glaucous-winged gulls, murres, parakeet auklets and puffins all exhibited average success in the northern Gulf of Alaska in 2009.

When all years were considered, we found negative population trends in 46% of cases (five of 11; species x site), stable populations in 46% of instances (five of 11) and increases in one case (9%, Table 36). Between 2000 and 2009, breeding seabird populations in this region declined in 30% of instances (three of 10), were stable in 50% of cases (five of 10) and exhibited increasing trends in 20% of instances (two of 10).

Southeast Alaska.–Hatch dates were early for fork-tailed storm-petrels and glaucous-winged gulls, and average for Leach's storm-petrels and murres at St. Lazaria Island in 2009 (Table 34).

Storm-petrels, pelagic cormorants, glaucous-winged gulls, murres and rhinoceros auklets had average or above average productivity in this region in 2009 (Table 35).

When all years were considered, we found negative population trends in 14% of cases (one of seven; species x site), stable populations in 43% of instances (three of seven) and increases in 43% of cases (three of seven, Table 36). Between 2000 and 2009, breeding seabird populations in this region declined in 14% of instances (one of seven), were stable in 57% of cases (four of seven) and exhibited increasing trends in 29% of instances (two of seven).

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All photographs used in this report are Fish and Wildlife Service pictures except those of the fork-tailed storm-petrel, parakeet auklet, least auklet, tufted puffin and horned puffin which were taken by Ian Jones, and the ancient murrelet taken by Fiona Hunter, and used with permission. Cover art by Susan Steinacher.

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Appendix 1. Masses of prey items used to estimate biomass for planktivore diet graphs (see Figures. 37, 41, 42 and 45).

	Taxon	Mass (g)
Crustaceans		
Amphipods		
	Anoyx spp.	0.0080
	Ansiogammarus pugetensis	0.0022
	Calliopius laeviusculus	0.0022
	Calliopius spp.	0.0022
	Cyphocaris challengeri	0.0022
	Ericthonius difformis	0.0022
	Ericthonius spp.	0.0022
	Unid. *Eusiridae*	0.0500
	Unid. *Gammaridae*	0.0500
	Halirages bungei	0.0500
	Unid. *Hyalidae*	0.2000
	Hyperia spp.	0.0020
	Hyperoche medusarum	0.0039
	Hyperoche spp.	0.1000
	Ischyrocerus spp.	0.0022
	Lamprops spp.	0.0100
	Unid. *Lysianassidae*	0.0040
	Onisimus spp.	0.0022
	Themisto libellula (<7mm)	0.0323
	Themisto libellula (>12mm)	0.1670
	Themisto pacifica (<4mm)	0.0037
	Themisto spp. (<4mm)	0.0039
	Pontogeneia spp.	0.0500
	Primno macropa	0.0030
	Unid. *Talitridae*	0.0022
	Unid. amphipod	0.0022
Copepods		
	Unid. *Calanidae*	0.0020
	Calanus marshallae	0.0013
	Calanus pacificus	0.0004
	Lophothrix frontalis	0.0020
	Neocalanus cristatus	0.0139
	Neocalanus plumchrus/flemingeri	0.0028
	Pachyptilus pacifica	0.0020
	Paraeuchaeta elongata	0.0200
	Unid. copepod	0.0075
Euphausiids		
	Euphausia pacifica	0.0227
	Unid. *Euphausiidae (furcilla)*	0.0060
	Unid. *Euphausiidae* (<7mm)	0.0060
	Unid. *Euphausiidae* (>7mm)	0.0227

Appendix 1 (continued). Masses of prey items used to estimate biomass for planktivore diet graphs (see Figures. 37, 41, 42 and 45).

		Taxon	Mass (g)
Crustaceans, cont'd			
	Euphausiids, Cont'd.	*Thysanoessa inermis* (<7mm)	0.0200
		Thysanoessa inermis (>12mm)	0.0750
		Thysanoessa longipes	0.0750
		Thysanoessa raschii (<7mm)	0.0305
		Thysanoessa raschii (>12mm)	0.0978
		Thysanoessa spp. (>12mm)	0.0790
	Decapods		
		Unid. *Atelecyclidae* megalopa	0.0150
		Unid. *Cheiragonidae* megalopa	0.0150
		Unid. *Crangonidae* zoea	0.0010
		Unid. *Crangonidae*	0.0050
		Diastylis bidentata	0.0022
		Unid. *Hippolytidae* megalopa	0.0370
		Unid. *Hippolytidae* zoea	0.0010
		Unid. shrimp larva	0.0120
		Unid. *Lithodidae* zoea	0.0010
		Unid. *Oregoniidae*	0.0010
		Unid. *Paguridae* glaucothoe	0.0050
		Unid. *Pandalidae* (>12mm)	0.0487
		Unid. *Pandalidae* larva (<7mm)	0.0120
		Unid. shrimp	0.0500
	Other		
		Unid. *Tanaidacea*	0.0500
		Unid. crustacean	0.0150
Molluscs			
	Gastropods		
		Limacina helicinia	0.0020
		Limacina spp.	0.0035
		Unid. Pterepod	0.0010
		Unid. snail	0.0050
	Cephalopods		
		Unid. *Gonatidae*	0.0600
		Unid. cephalopod	0.0600
		Unid. squid	0.0600
	Other		
		Unid. mollusc	0.0050
Insects			
		Unid. *Tipulidae*	0.0001
		Unid. Insect	0.0010
Fish			
		Ammodytes hexapterus (0 yr)	2.0000
		Ammodytes hexapterus (1+ yr)	5.0000

Appendix 1 (continued). Masses of prey items used to estimate biomass for planktivore diet graphs (see Figures. 37, 41, 42 and 45).

	Taxon	Mass (g)
Fish, cont'd		
	Hexagrammos spp. (1+ yr)	11.000
	Stenobrachius leucopsarus (0 yr)	2.1000
	Stenobrachius spp. (0 yr)	2.1000
	Unid. *myctophidae*	2.1000
	Unid. fish larvae	0.4850
Other		
	Plastic (large)	0.0200
	Plastic (small)	0.0100