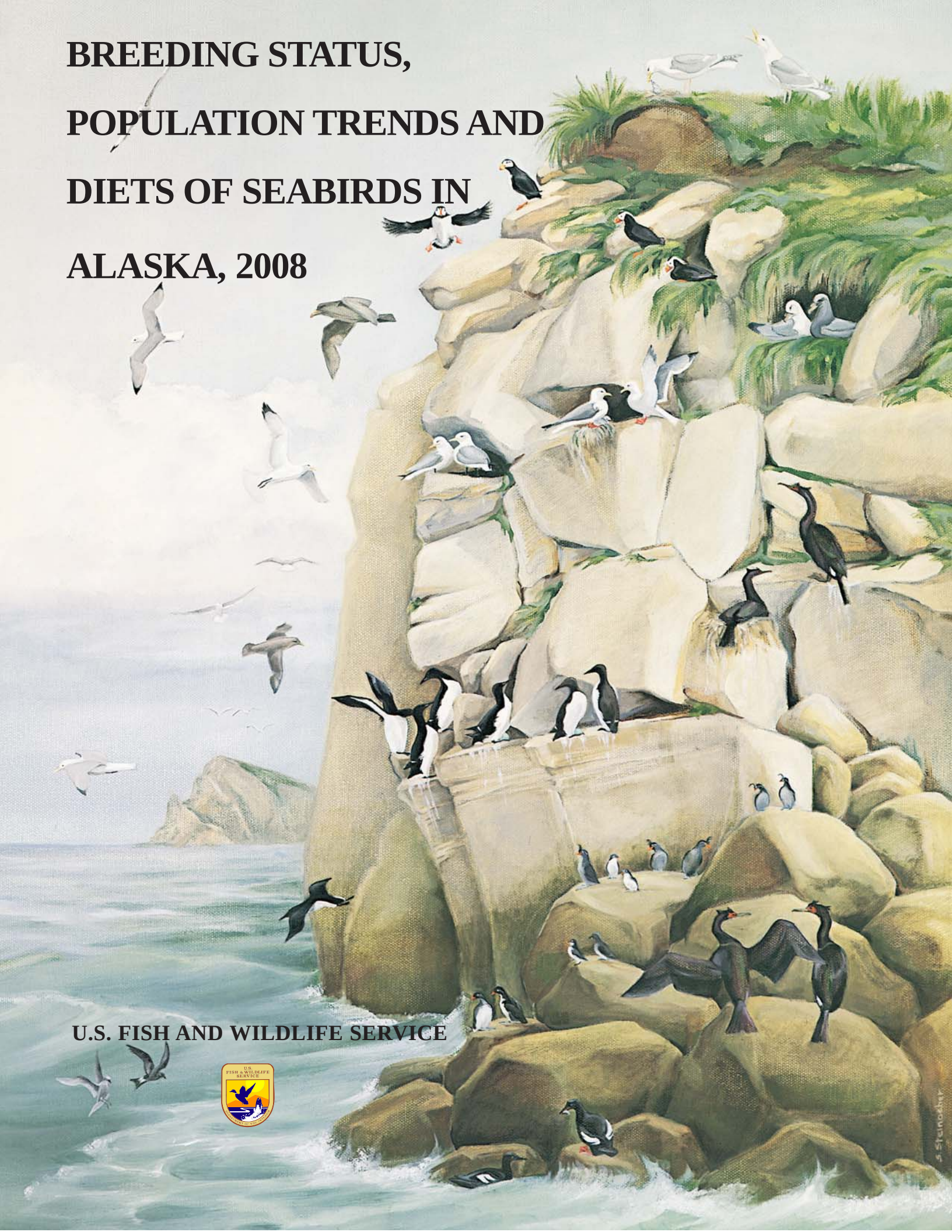
BREEDING STATUS, POPULATION TRENDS AND DIETS OF SEABIRDS IN ALASKA, 2008



U.S. FISH AND WILDLIFE SERVICE

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BREEDING STATUS, POPULATION TRENDS AND DIETS OF SEABIRDS IN ALASKA, 2008

Compiled By:

Donald E. Dragoo, G. Vernon Byrd, and David B. Irons[a]

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Executive Summary

Data are being 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 (e.g., chicks fledged per nest), population trends and diet composition of representative species of various foraging guilds (e.g., offshore diving fish-feeders, offshore surface-feeding 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. This report is the thirteenth in a series of annual reports summarizing the results of seabird monitoring efforts at breeding colonies on the Alaska Maritime NWR and elsewhere in Alaska.

In summer 2008 data were gathered on northern fulmars, storm-petrels, cormorants, glaucous-winged gulls, kittiwakes, murres, pigeon guillemots, ancient murrelets, auklets and/or puffins at ten 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.

In 2008, most species exhibited average or earlier than average nesting phenology. Timing of nesting of plankton-feeders (storm-petrels and auklets) was normal or early in all but one case. Fish-feeders (cormorants, gulls, kittiwakes, murres, murrelets, rhinoceros auklets, puffins) were earlier than normal in 11 of 25 cases (species x site), average in 10 instances and late in four cases. When we averaged the relative hatching chronology for each species statewide, we found that timing was early for four species, average for eight species and late for three species. Overall, seabird breeding chronology in Alaska was average in 2008.

In 2008, most seabirds exhibited average or above average productivity. Success of plankton-feeders (storm-petrels and auklets) was average or above average in all but three instances. Fish-feeders (cormorants, gulls, kittiwakes, murres, murrelets, rhinoceros auklets, puffins) exhibited low productivity in 11 of 43 cases (species x site), average success in 13 instances and better than average productivity in 19 cases. Statewide, we found that productivity was average for 10 species and above average for six species in 2008. Overall, seabirds exhibited above average productivity in Alaska in 2008.

In the decade between 1999 and 2008, plankton-feeders (storm-petrels and auklets) exhibited declines in one of 6 cases (species x site) and stable numbers in five instances. During that time period, fish-feeders (northern fulmars, cormorants, gulls, kittiwakes, murres, pigeon guillemots, rhinoceros auklets, puffins) exhibited stable populations in 17 of 53 cases, increases in 19 instances and declines in 17 cases. When we averaged the population trends for the last decade (1999-2008) for each species statewide, we found that three species showed declining trends, 10 species were stable and four species were increasing. Overall, Alaskan seabird populations were stable between 1999 and 2008.

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Introduction

This report is the thirteenth 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 2006-2010 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 10 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 2008. Furthermore, data are recorded annually or semiannually at other sites in Alaska (e.g., Middleton Island). 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 2008 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 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.

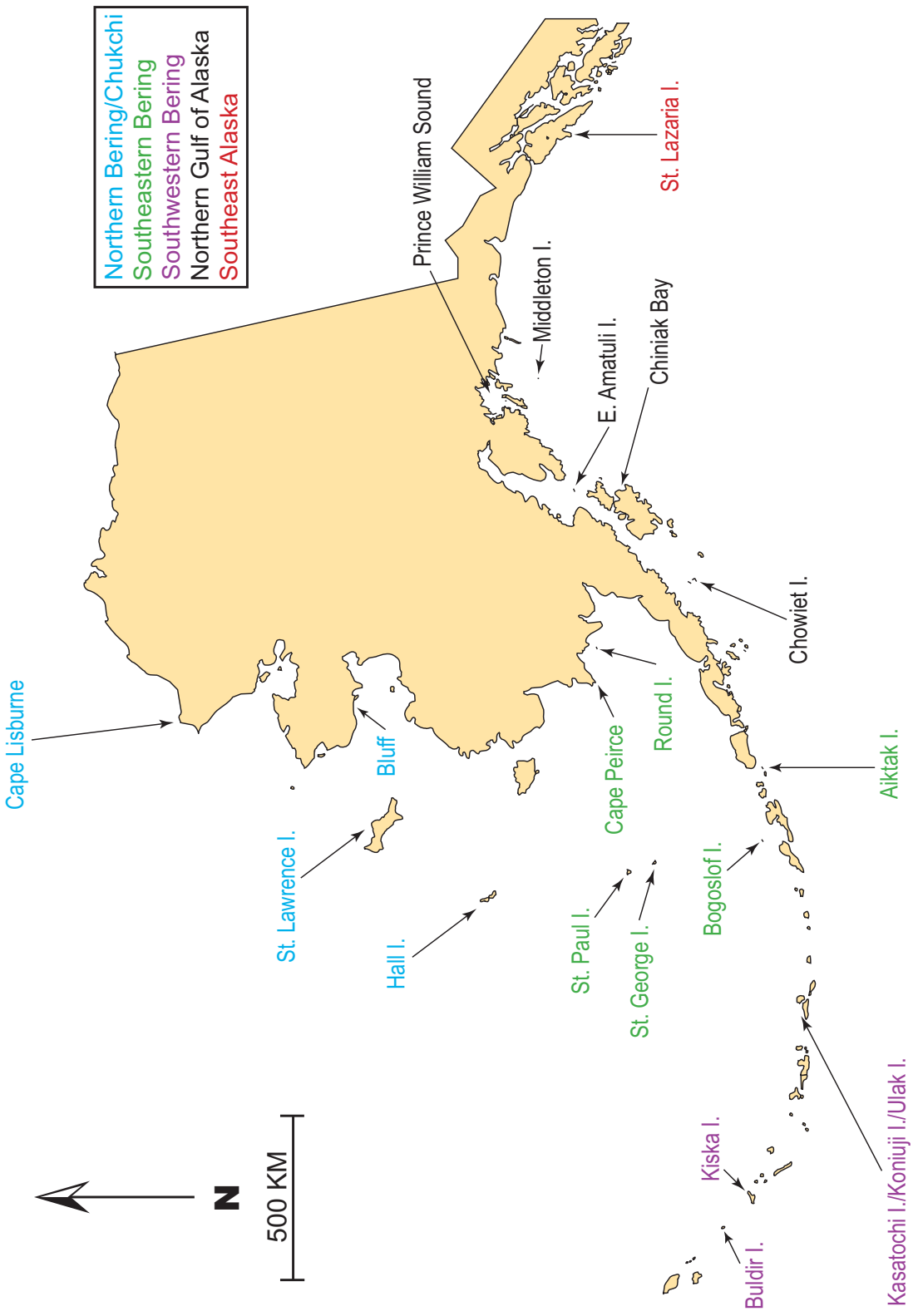

Figure 1. Map of Alaska showing the locations of seabird monitoring sites summarized in this report. Text color indicates geographic regions.

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 2008, and compares 2008 results with previous years. For sites with at least two years of data prior to 2008, 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 analysed using two time frames: 1) data from all available years, and 2) data from the last decade (1999-2008 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 1999-2008, 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, and each species carried equal weight in calculating the statewide average. The chronology was averaged for all sites within each region resulting in a value for each species and a value for all species within each region. Species chronologies were then averaged to calculate a value for the entire state. This method produced one statewide value for each species, a value for all species within each region and one value for all species (combined) for the entire state.

Productivity was calculated for each species in a region using data from all colonies. Each colony was weighted equally within each region, and each species carried equal weight in calculating the statewide average. The productivity was averaged for all sites within each region resulting in a value for each species and a value for all species within each region. Species productivities were then averaged to calculate a value for the entire state.

Population trends were calculated for each species in a region using data from all colonies. Each colony was weighted equally within each region, and each species carried equal weight in calculating the statewide average. Trends (line slopes) were averaged for all sites within each region resulting in a value for each species and a value for all species within each region. Species trends were then averaged to calculate a value (slope) for the entire state. Only sites for which there were data from at least two years (at least 5 years apart) within the last decade were included in regional and statewide comparisons.

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 each graph. 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 2008.

Productivity.–No data for 2008.

Populations.–We found no trends for northern fulmar populations all years at Hall Island; data were insufficient there to assess recent trends. No trends were evident during either time period at St. Paul or St. George islands. Fulmar populations were stable overall at Chowiet Island and increased there between 1999 and 2008 (Figure 2).

Diet.–No data.

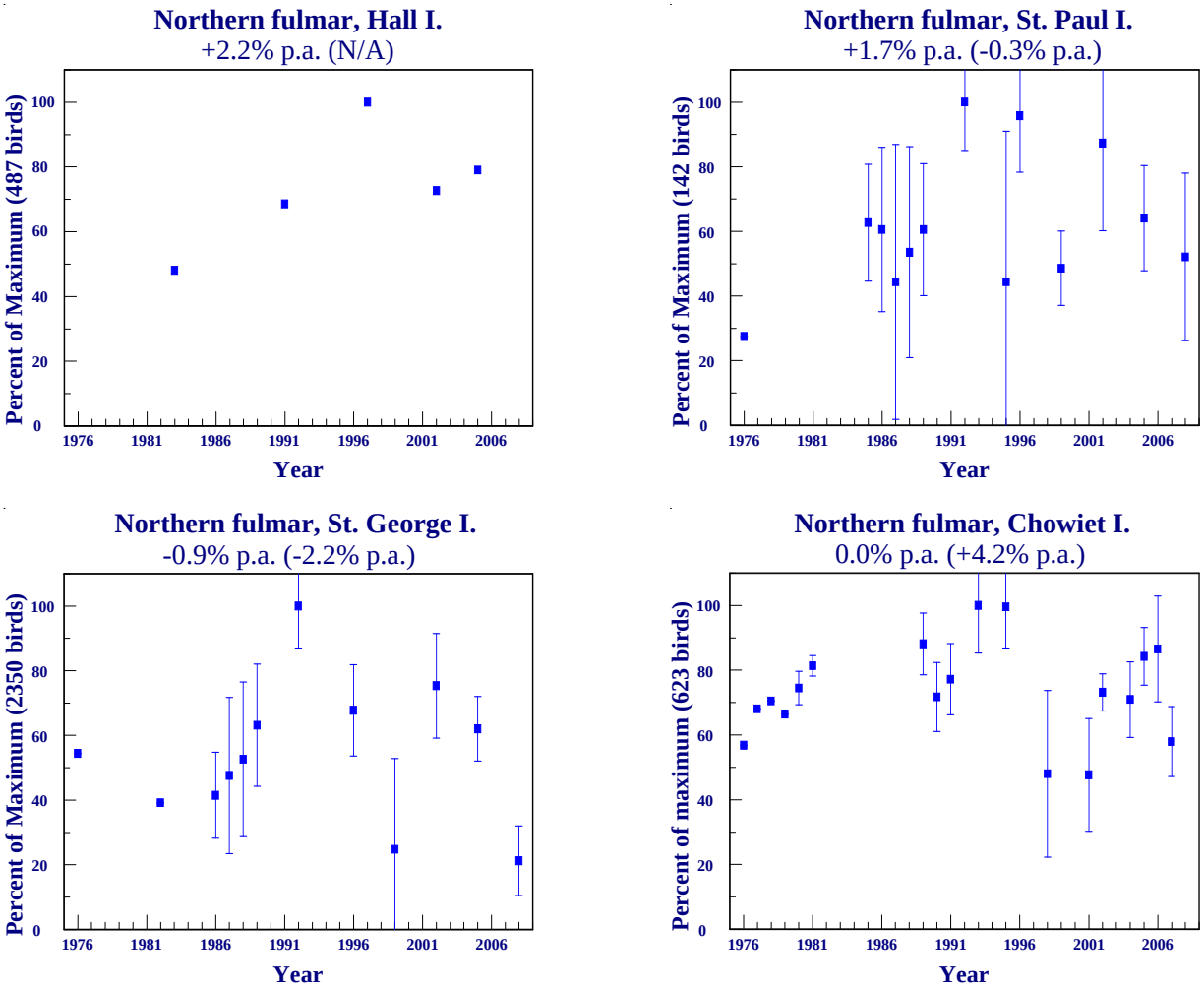

Figure 2. Trends in populations of northern fulmars at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (1999-2008, in parentheses). "N/A" indicates that insufficient 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 2008 (Table 2, Figure 3).

Table 2. Hatching chronology of fork-tailed storm-petrels at Alaskan sites monitored in 2008.

Site	Median	Mean	Long-term Average	Reference
Aiktak I.	—	12 Jul (28)[a]	16 Jul[b] (11)[a]	Sapora et al. 2010
St. Lazaria I.	—	2 Jul (55)	14 Jul[b] (13)	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 2008, productivity of fork-tailed storm-petrels was low at Kasatochi Island, about average at Buldir and Aiktak islands, 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 2008.

Site	Chicks Fledged[a]/Egg	No. of Plots	Long-term Average	Reference
Buldir I.	0.81	5 (77)[b]	0.74 (22)[b]	Freeman et al. 2010
Kasatochi I	0.45	N/A[c] (115)	0.64 (4)	Buchheit and Ford 2008
Aiktak I.	0.70	13 (50)	0.84 (8)	Sapora et al. 2010
St. Lazaria I.	0.81	8 (218)	0.62 (12)	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.
[c]Not applicable or not reported.

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 the last decade at any monitored colony (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.

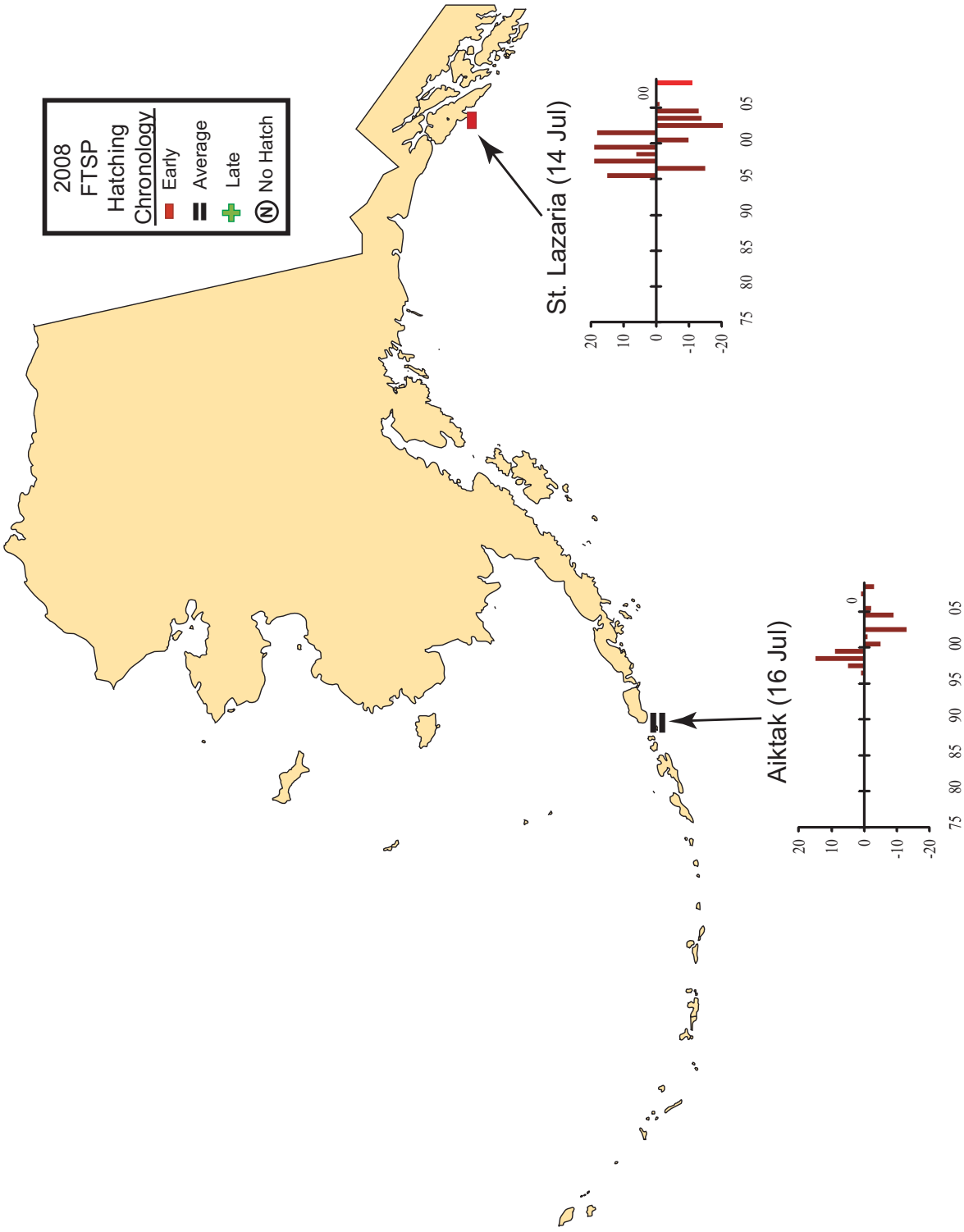

Figure 3. Hatching chronology of fork-tailed storm-petrels at Alaskan sites monitored in 2008. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

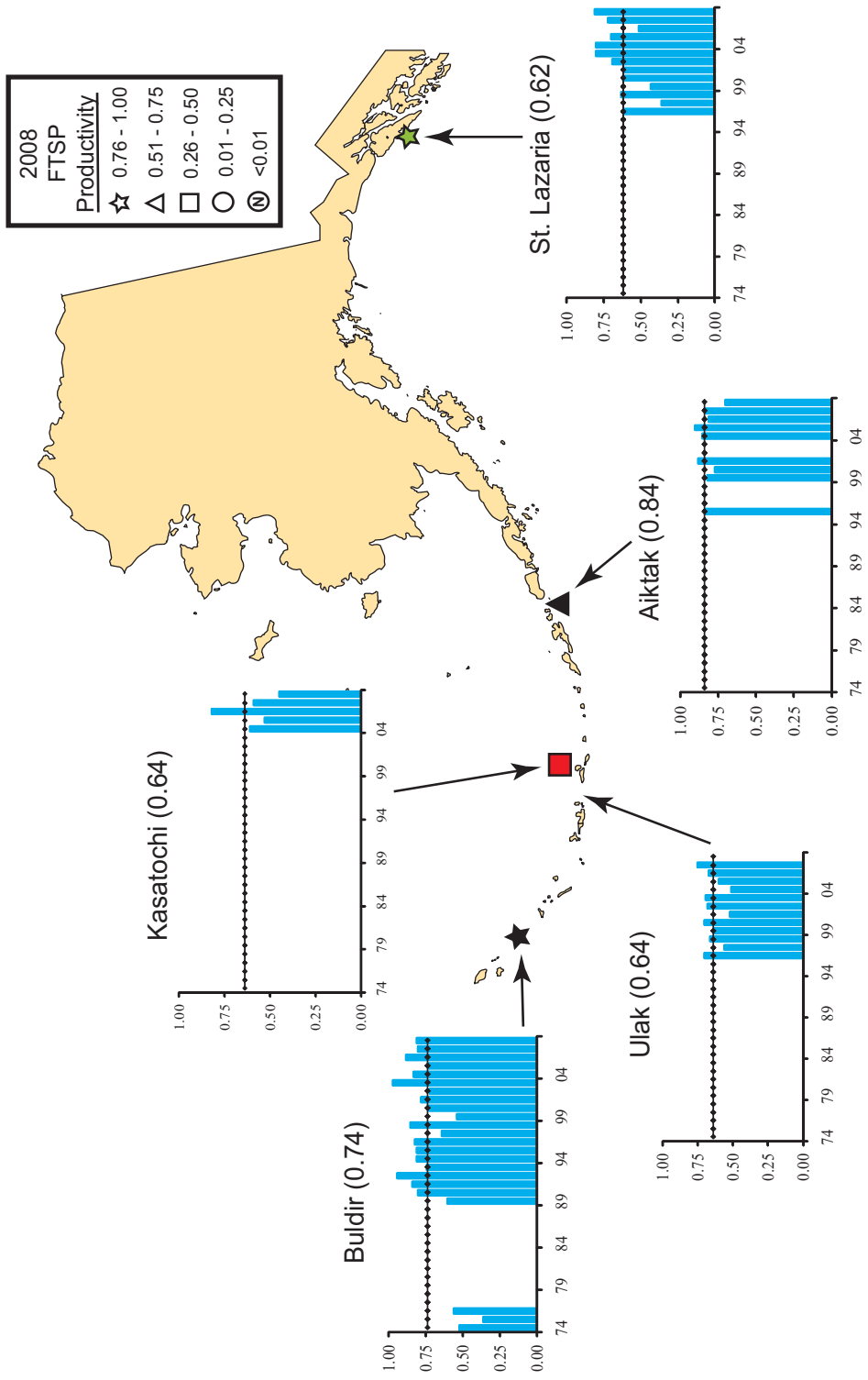

Figure 4. Productivity of fork-tailed storm-petrels (chicks fledged/egg) at Alaskan sites monitored in 2008. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

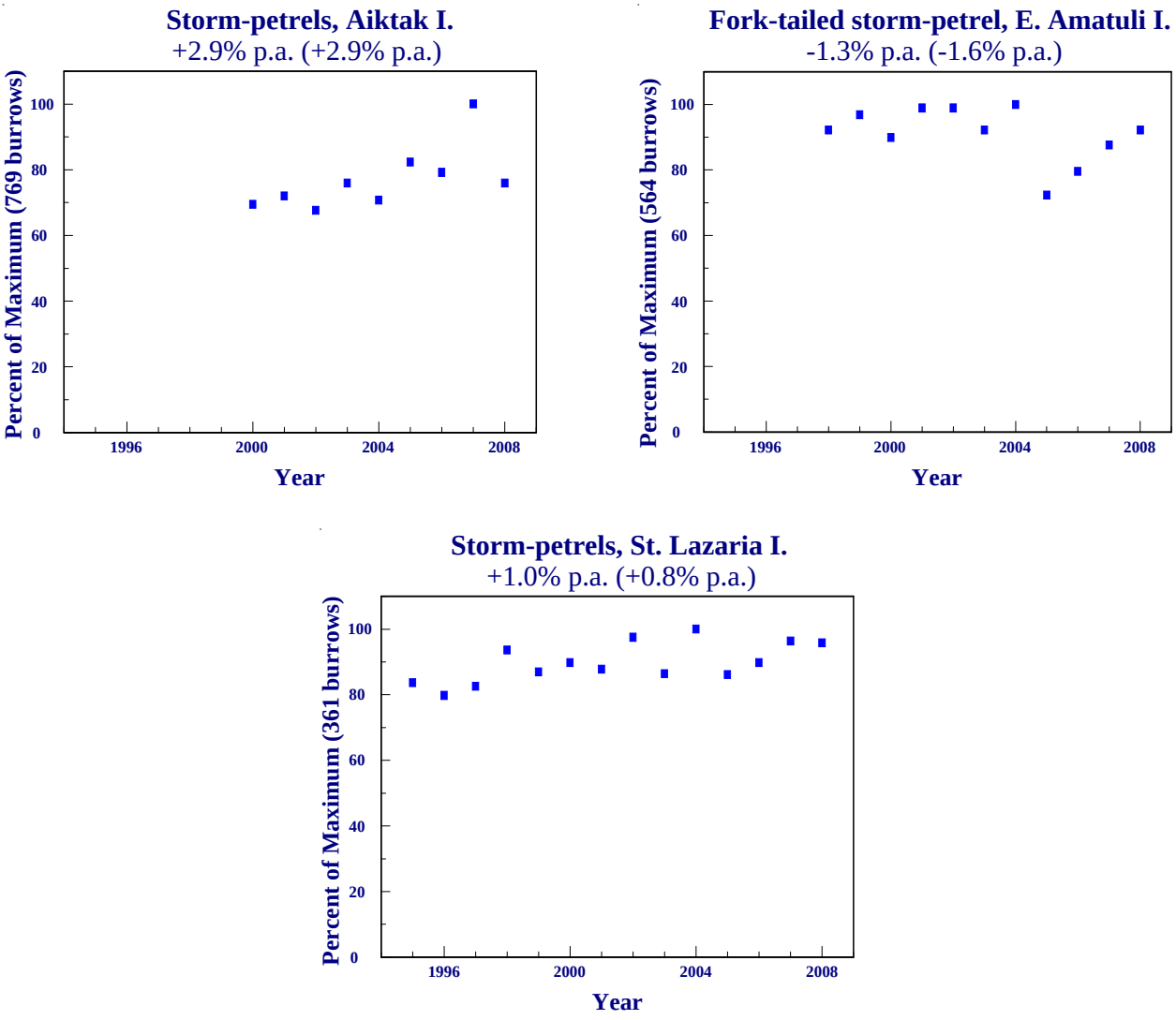

Figure 5. Trends in populations of storm-petrels at Alaskan sites. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (1999-2008, in parentheses).

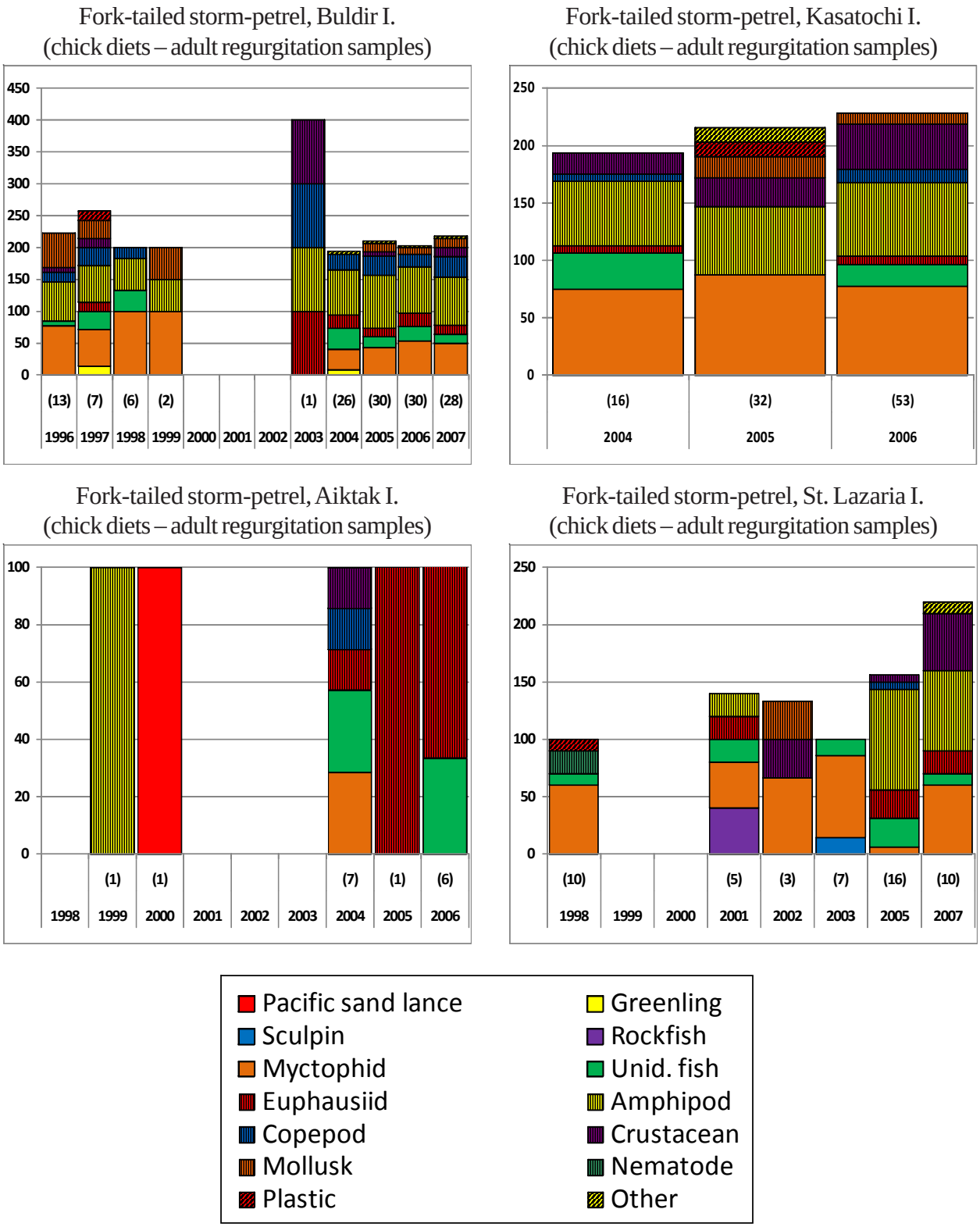

Figure 6. Diets of fork-tailed storm-petrels at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

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 2008 (Table 4, Figure 7).

Table 4. Hatching chronology of Leach's storm-petrels at Alaskan sites monitored in 2008.

Site	Median	Mean	Long-term Average	Reference
Aiktak I.	—	30 Jul (45)[a]	1 Aug[b] (11)[a]	Sapora et al. 2010
St. Lazaria I.	—	29 Jul (30)	31 Jul[b] (13)	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 2008, 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 2008.

Site	Chicks Fledged[a]/Egg	No. of Plots	Long-term Average	Reference
Buldir I.	0.83	5 (78)[b]	0.73 (22)[b]	Freeman et al. 2010
Aiktak I.	0.86	13 (77)	0.86 (8)	Sapora et al. 2010
St. Lazaria I.	0.61	8 (147)	0.57 (12)	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 the last decade at any monitored colony (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.

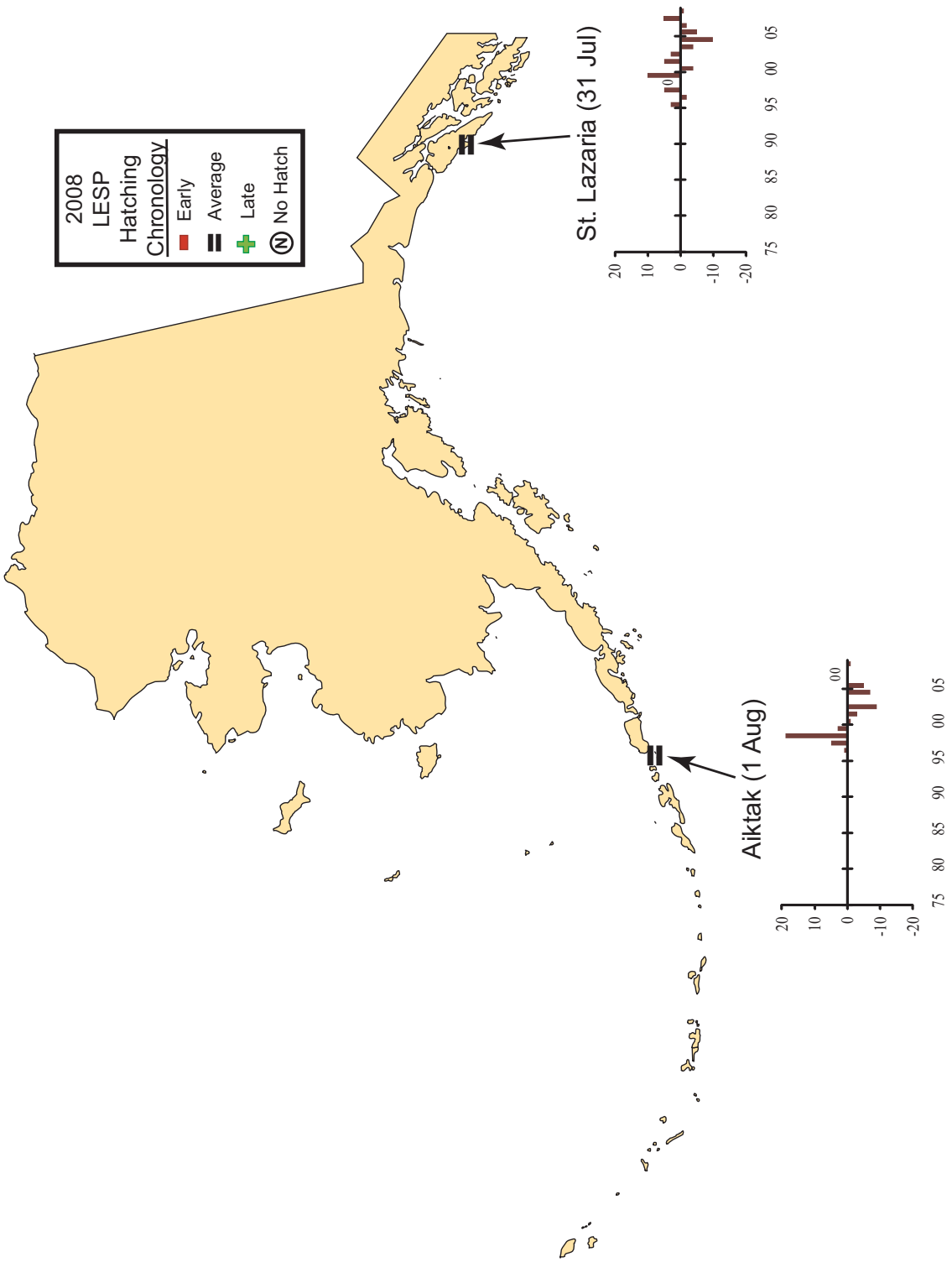

Figure 7. Hatching chronology of Leach's storm-petrels at Alaskan sites monitored in 2008. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

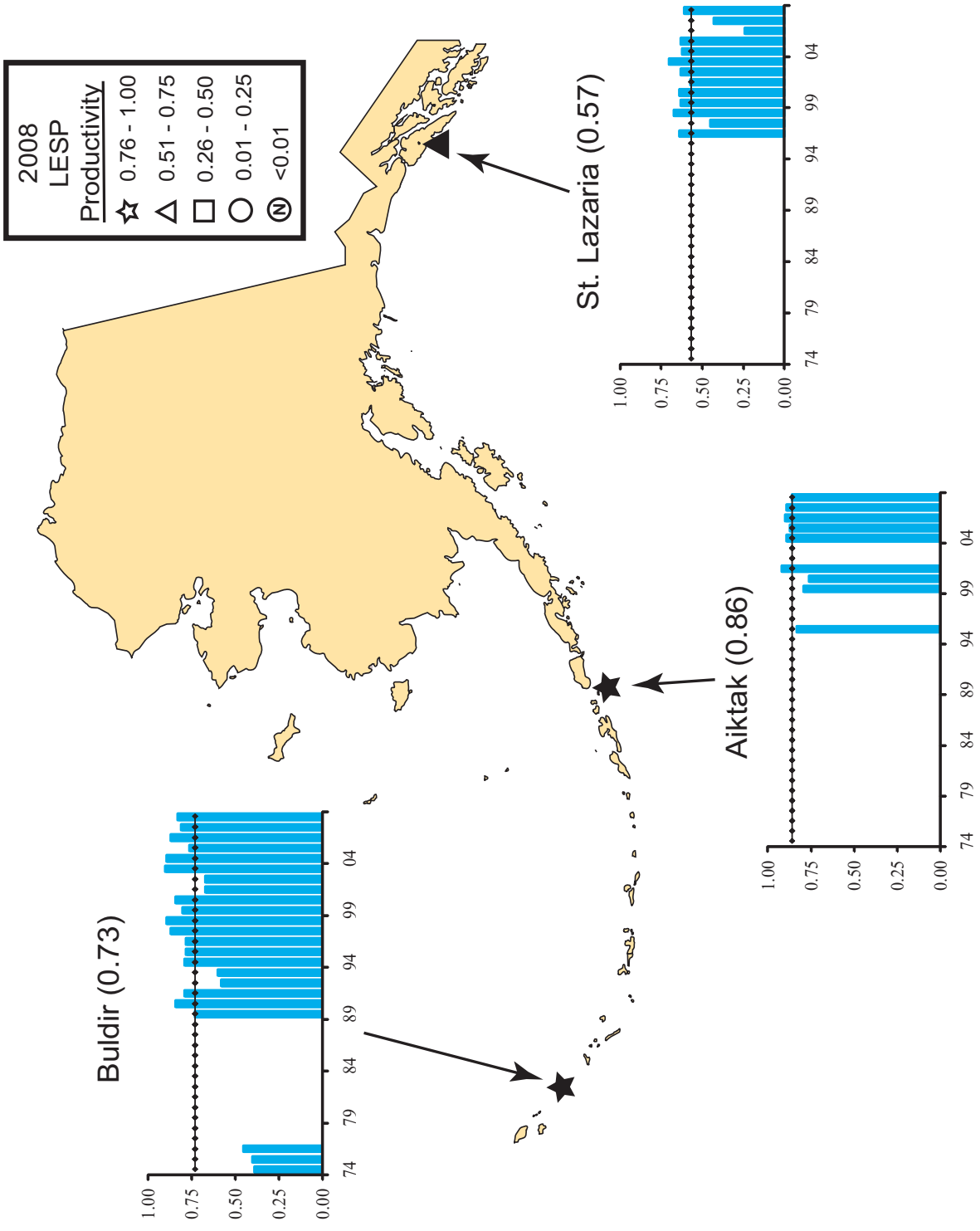

Figure 8. Productivity of Leach's storm-petrels (chicks fledged/egg) at Alaskan sites monitored in 2008. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

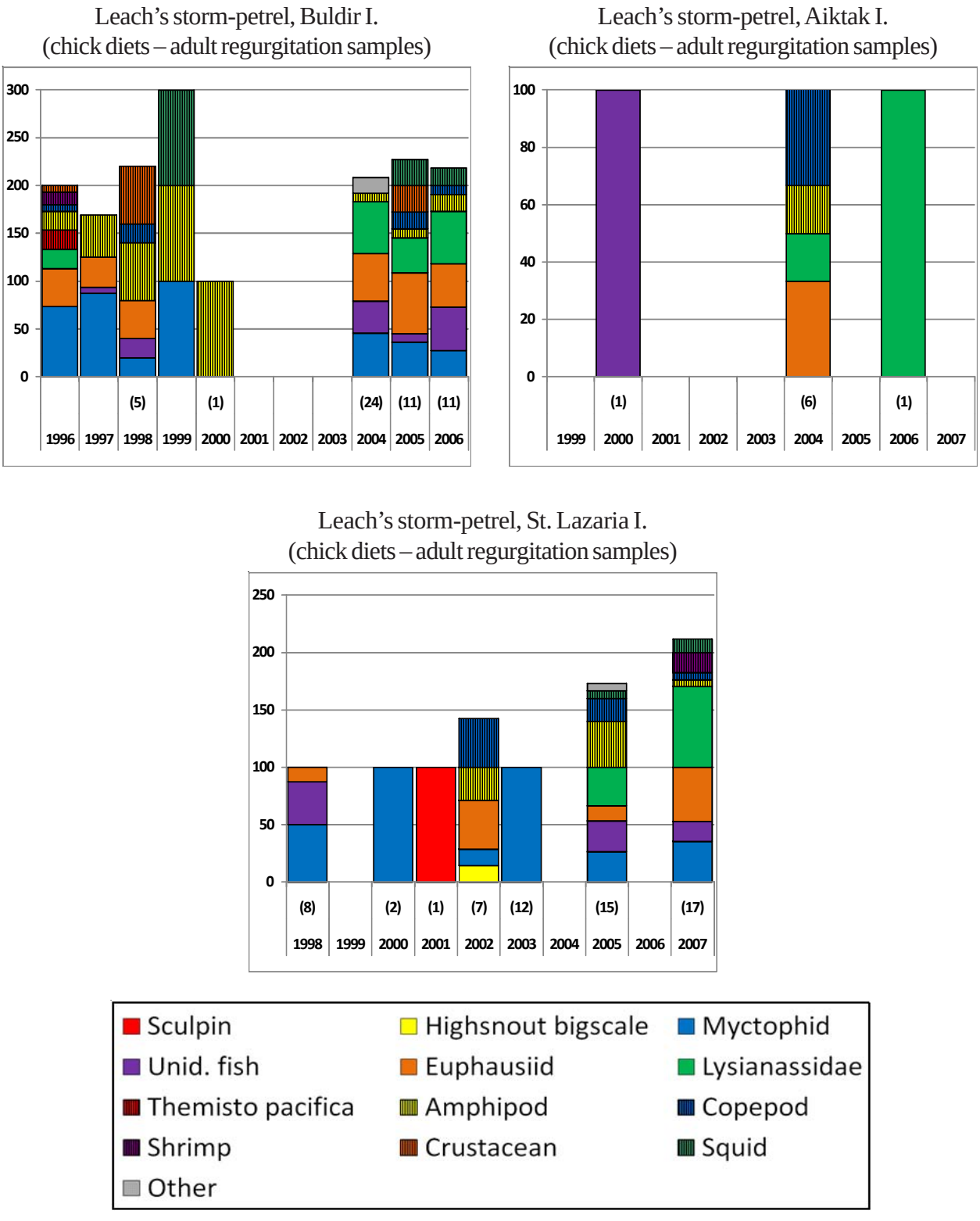

Figure 9. Diets of Leach's storm-petrels at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes, when available, are reported below each bar.

Red-faced cormorant (*Phalacrocorax urile*)

Breeding chronology.–Timing of hatching of red-faced cormorant eggs was late at St. Paul Island in 2008 (Table 6).

Table 6. Hatching chronology of red-faced cormorants at Alaskan sites monitored in 2008.

Site	Mean	Long-term Average	Reference
St. Paul I.	11 Jul (16)[a]	28 Jun[b] (19)[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 2008, productivity of red-faced cormorants was below average at St. George Island, average at Buldir and Aiktak islands, and above average at St. Paul Island (Table 7, Figure 10).

Table 7. Reproductive performance of red-faced cormorants at Alaskan sites monitored in 2008.

Site	Chicks Fledged/Nest	No. of Plots	Long-term Average	Reference
St. Paul I.	1.55	2 (38)[a]	1.20 (24)[a]	McClintock et al. 2010
St. George I.	0.47	2 (30)	1.36 (11)	Shannon et al. 2010
Buldir I.	1.56	N/A[b] (9)	1.66 (4)	Freeman et al. 2010
Aiktak I.	0.63	N/A (248)	0.78 (5)	Sapora 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.–Red-faced cormorants were differentiated from other cormorants at only one colony. We found a decline in the number of nests in all years at Chiniak Bay but an increase there since 1999 (Figure 11). We found a negative trend in the number of cormorant nests (species combined) at Ulak Island during the last decade, as well as in all years. At Aiktak and Kasatochi islands, cormorants showed no trends over all years but numbers have declined at both colonies since 1999.

Diet.–No data.

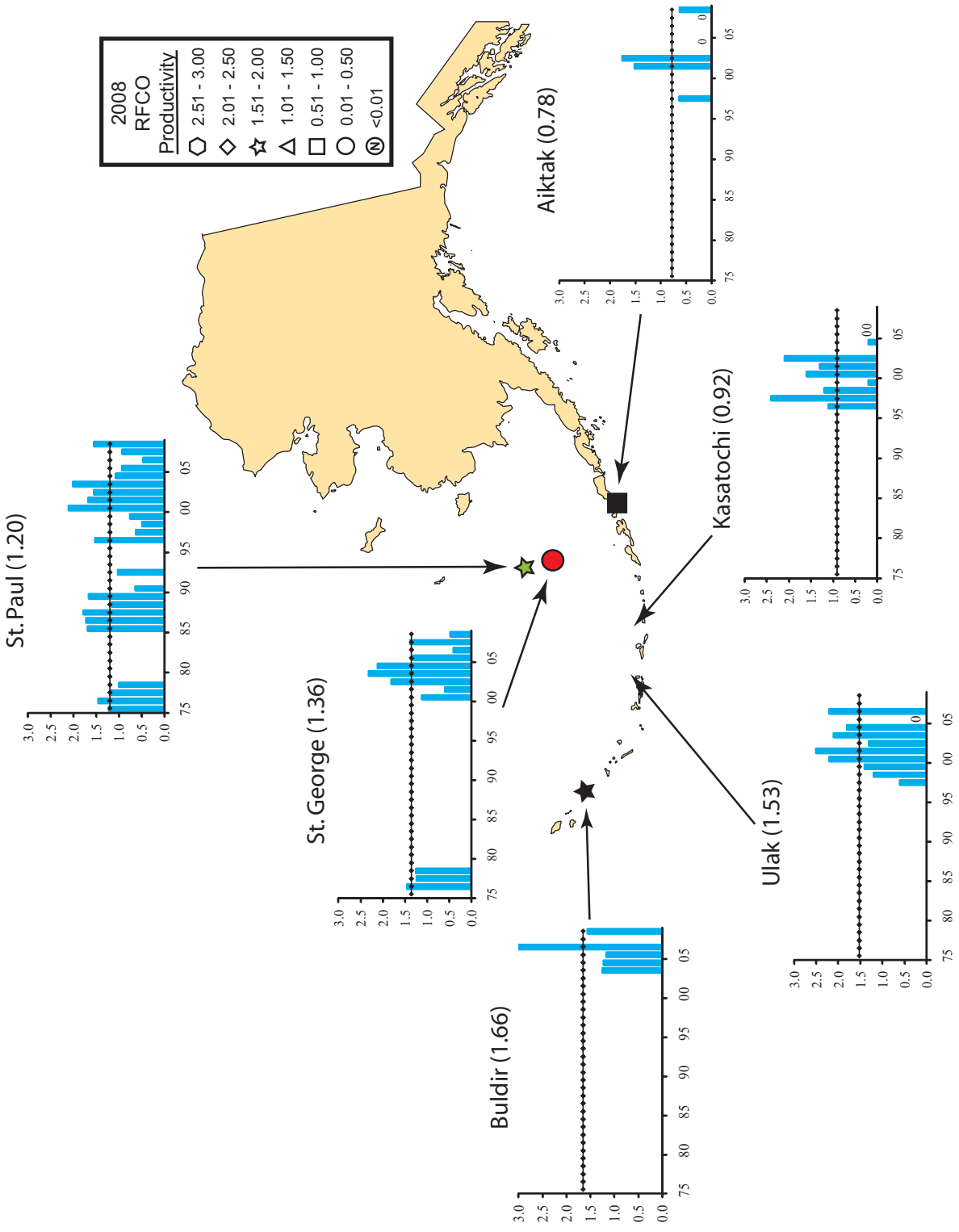

Figure 10. Productivity of red-faced cormorants (chicks fledged/nest) at Alaskan sites monitored in 2008. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

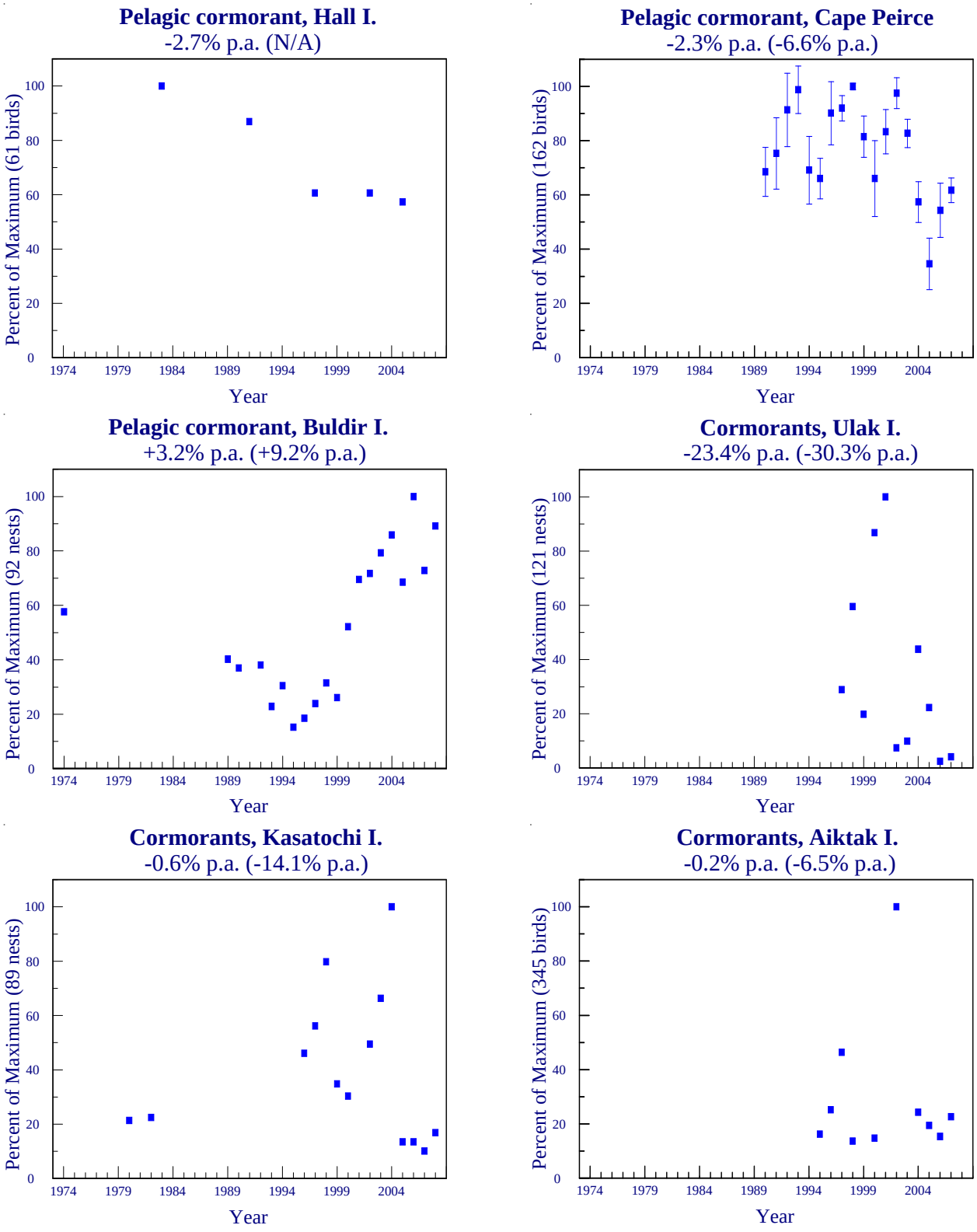

Figure 11. Trends in populations of cormorants at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (1999-2008, in parentheses). “N/A” indicates that insufficient data were available.

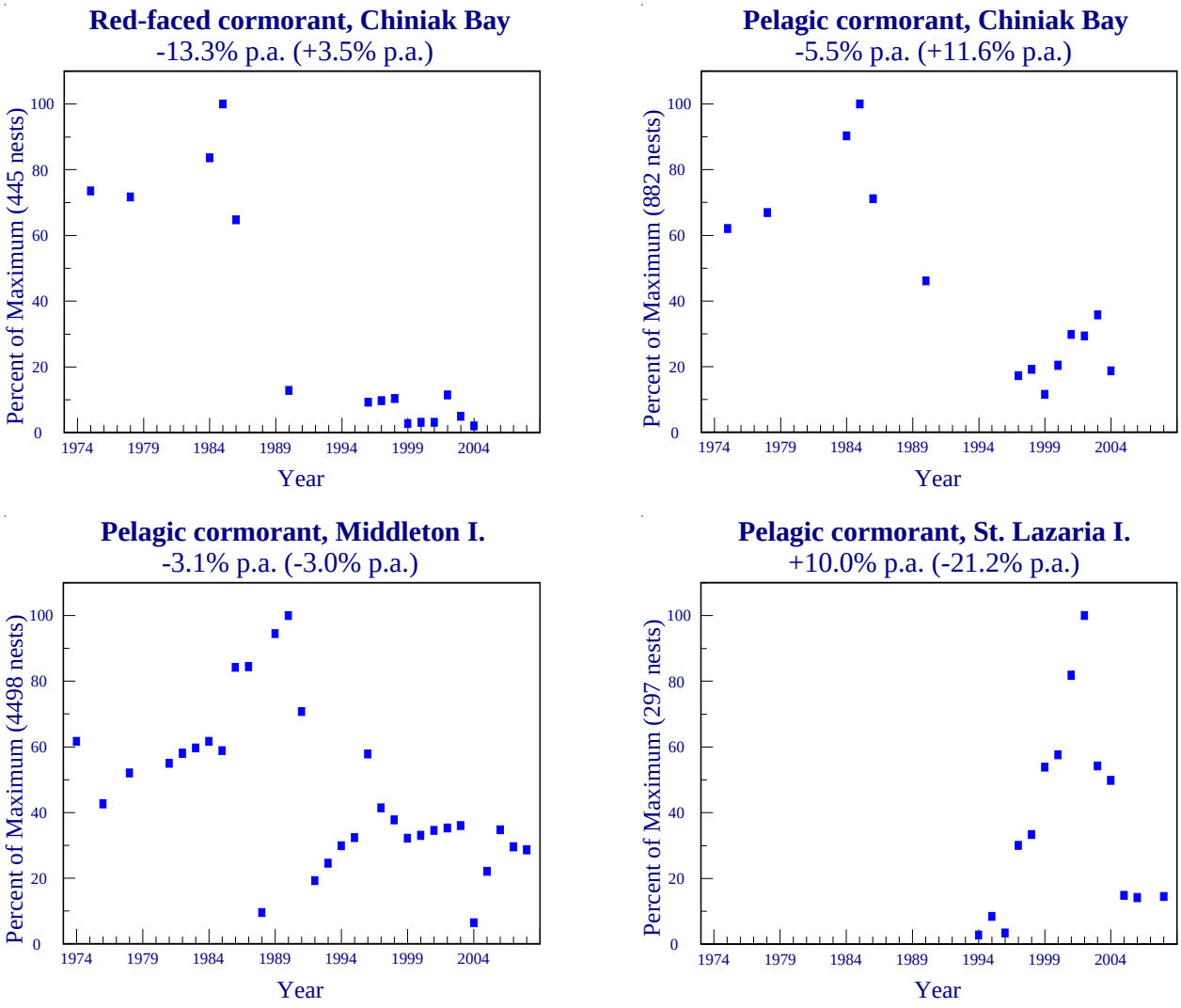

Figure 11 (continued). Trends in populations of cormorants at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (1999-2008, in parentheses). “N/A” indicates that insufficient data were available.

Pelagic cormorant (*Phalacrocorax pelagicus*)

Breeding chronology.–No data for 2008.

Productivity.–Pelagic cormorant productivity was below average at St. Lazaria Island, average at Round Island and above average at the four other sites monitored in 2008 (Table 8, Figure 12).

Table 8. Reproductive performance of pelagic cormorants at Alaskan sites monitored in 2008.

Site	Chicks Fledged/Nest	No. of Plots	Long-term Average	Reference
Bluff	2.88	5 (16)[a]	1.99 (15)[a]	Murphy 2009
Round I.	1.63	2 (59)	1.62 (7)	Okonek et al. 2008
Buldir I.	1.23	N/A[b] (82)	0.93 (18)	Freeman et al. 2010
Kasatochi I.	1.90	N/A (15)	1.09 (12)	Buchheit and Ford 2008
Aiktak I.	1.75	N/A (69)	1.06 (7)	Sapora et al. 2010
St. Lazaria I.	0.20	N/A (43)	0.59 (14)	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 to assess trends during the last decade (Figure 11). This species showed no trend overall at Cape Peirce but declined there since 1999. Numbers of nests increased both in all years and during the last decade at Buldir Island. Cormorant nest numbers have declined overall at Chiniak Bay but have recovered somewhat since 1999. Nest numbers were down both overall and in recent years at Middleton Island, whereas an overall positive trend reversed at St. Lazaria since 1999.

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

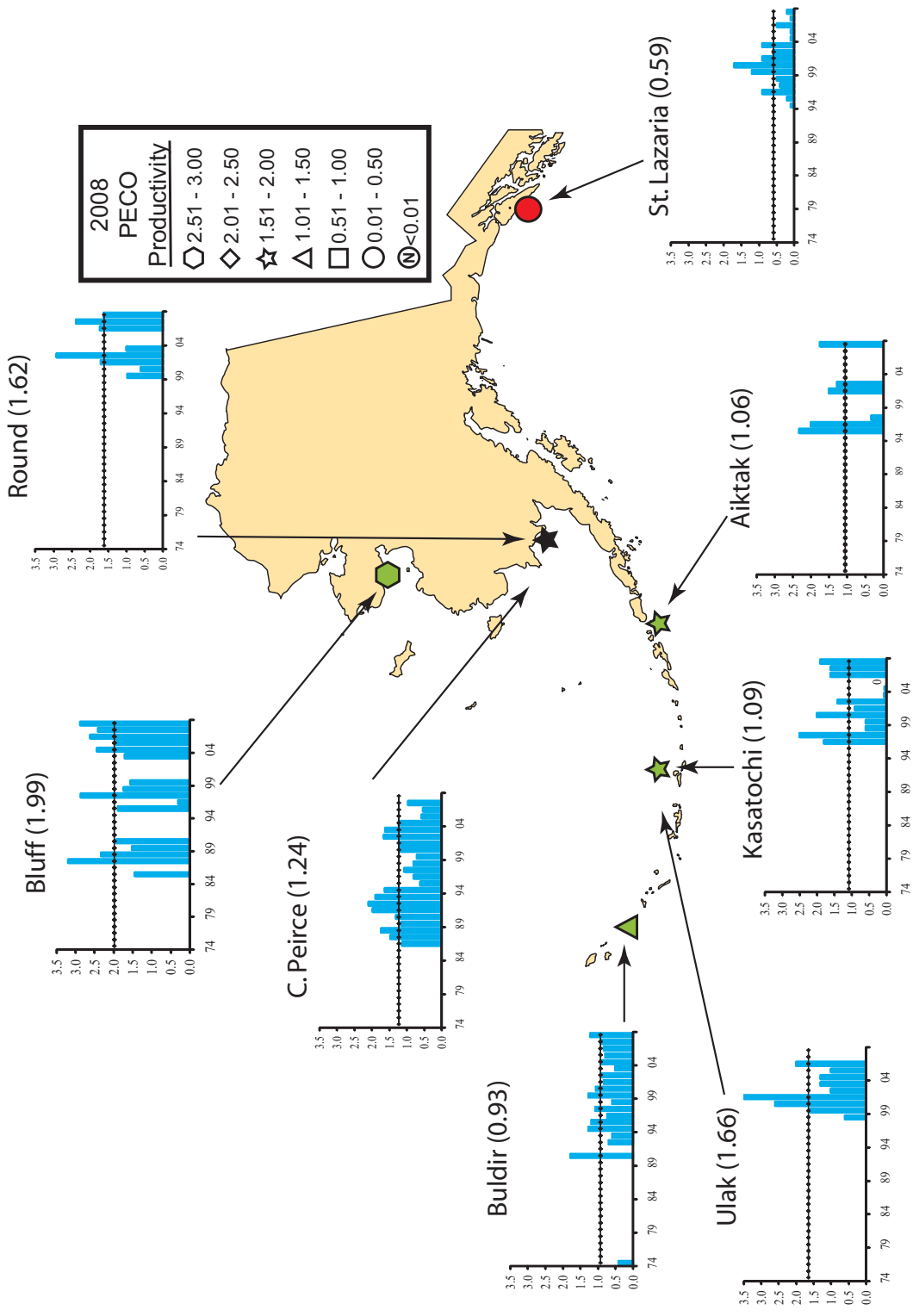

Figure 12. Productivity of pelagic cormorants (chicks fledged/nest) at Alaskan sites monitored in 2008. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

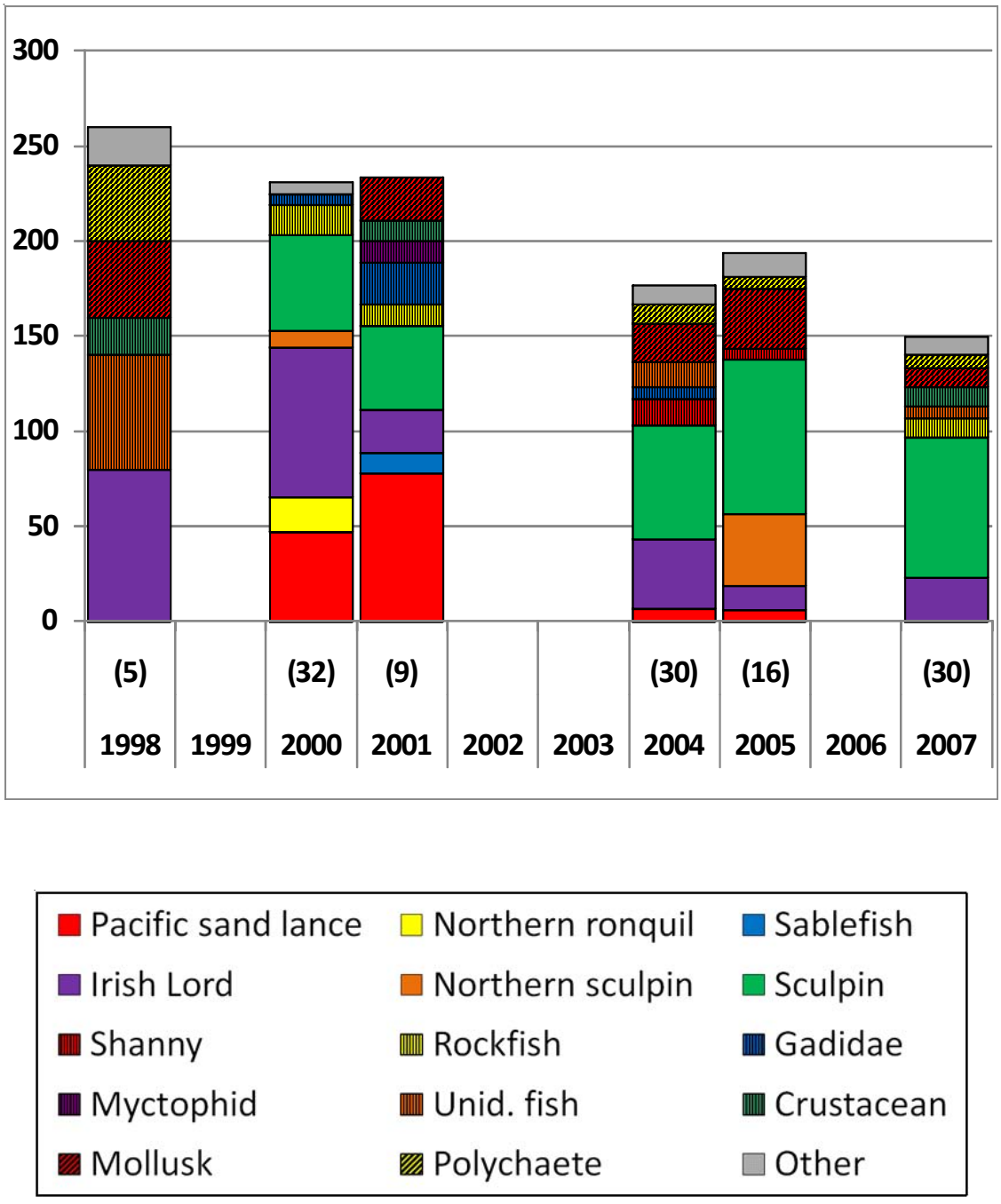

Figure 13. Diets of pelagic cormorants at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Glaucous-winged gull (*Larus glaucescens*)

Breeding chronology.–In 2008, glaucous-winged gull mean hatch date was average at Aiktak and St. Lazaria islands (Table 9, Figure 14).

Table 9. Hatching chronology of glaucous-winged gulls at Alaskan sites monitored in 2008.

Site	Median	Mean	Long-term Average	Reference
Aiktak I.	—	8 Jul (40)[a]	9 Jul[b] (13)[a]	Sapora et al. 2010
St. Lazaria I.	2 Jul (78)	3 Jul (78)	5 Jul[b] (9)	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 2008 was above average at Buldir and St. Lazaria islands, and below average at Aiktak Island (Table 10, Figure 15).

Table 10. Reproductive performance of glaucous-winged gulls at Alaskan sites monitored in 2008.

Site	Hatching Success[a]	No. of Plots	Long-term Average	Reference
Buldir I.	0.60	N/A[b] (55)[c]	0.29 (15)[c]	Freeman et al. 2010
Aiktak I.	0.27	N/A (313)	0.69 (13)	Sapora et al. 2010
St. Lazaria I.	0.74	N/A	0.54 (14)	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 since 1999 as well (Figure 16). Gull numbers were stable in all years at Kasatochi Island and have increased there in the last decade. 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 since 1999. 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 overall, and during the last decade, at St. Lazaria Island.

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 17). 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.

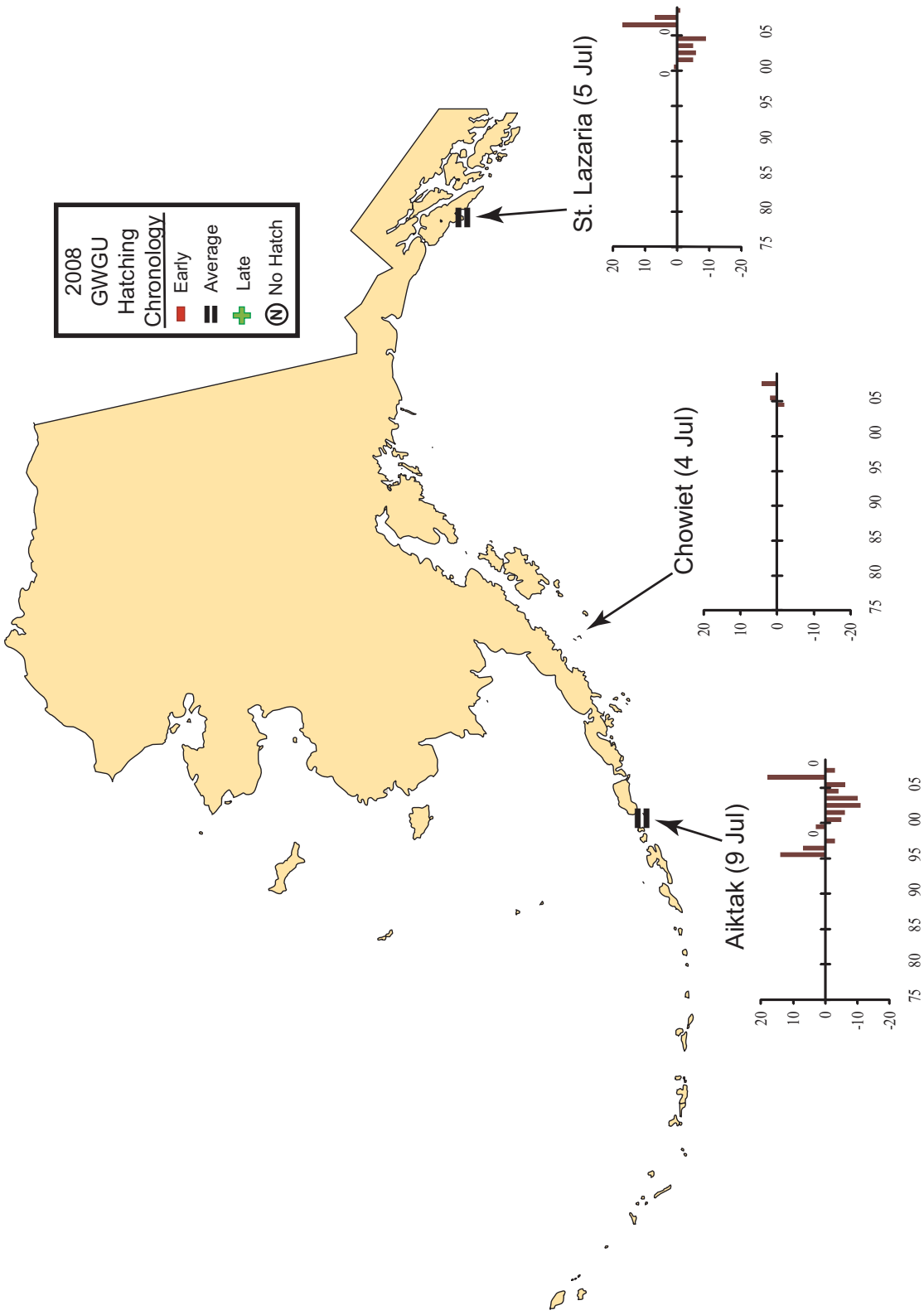

Figure 14. Hatching chronology of glaucous-winged gulls at Alaskan sites monitored in 2008. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

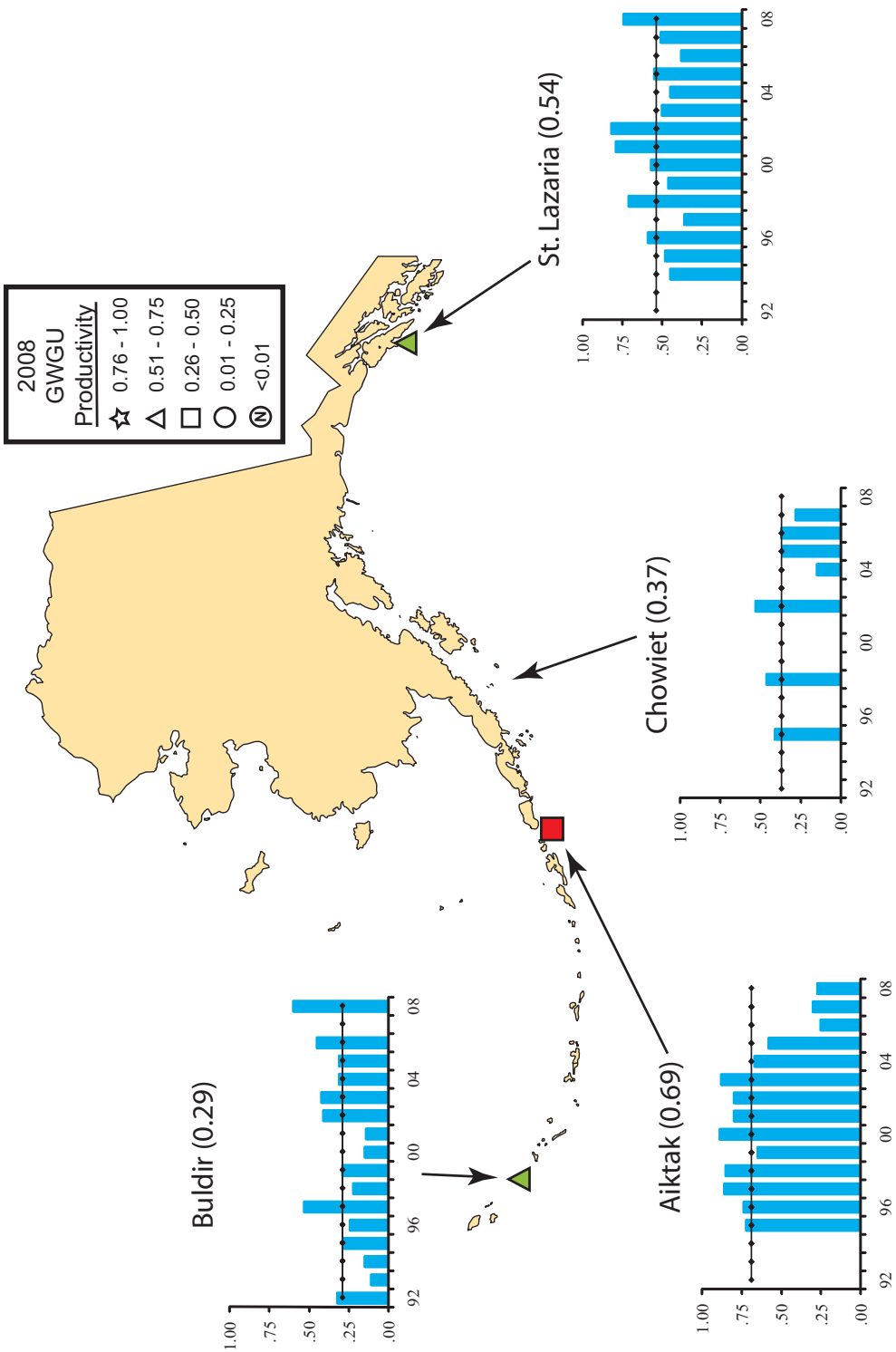

Figure 15. Productivity of glaucous-winged gulls (hatching success) at Alaskan sites monitored in 2008. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

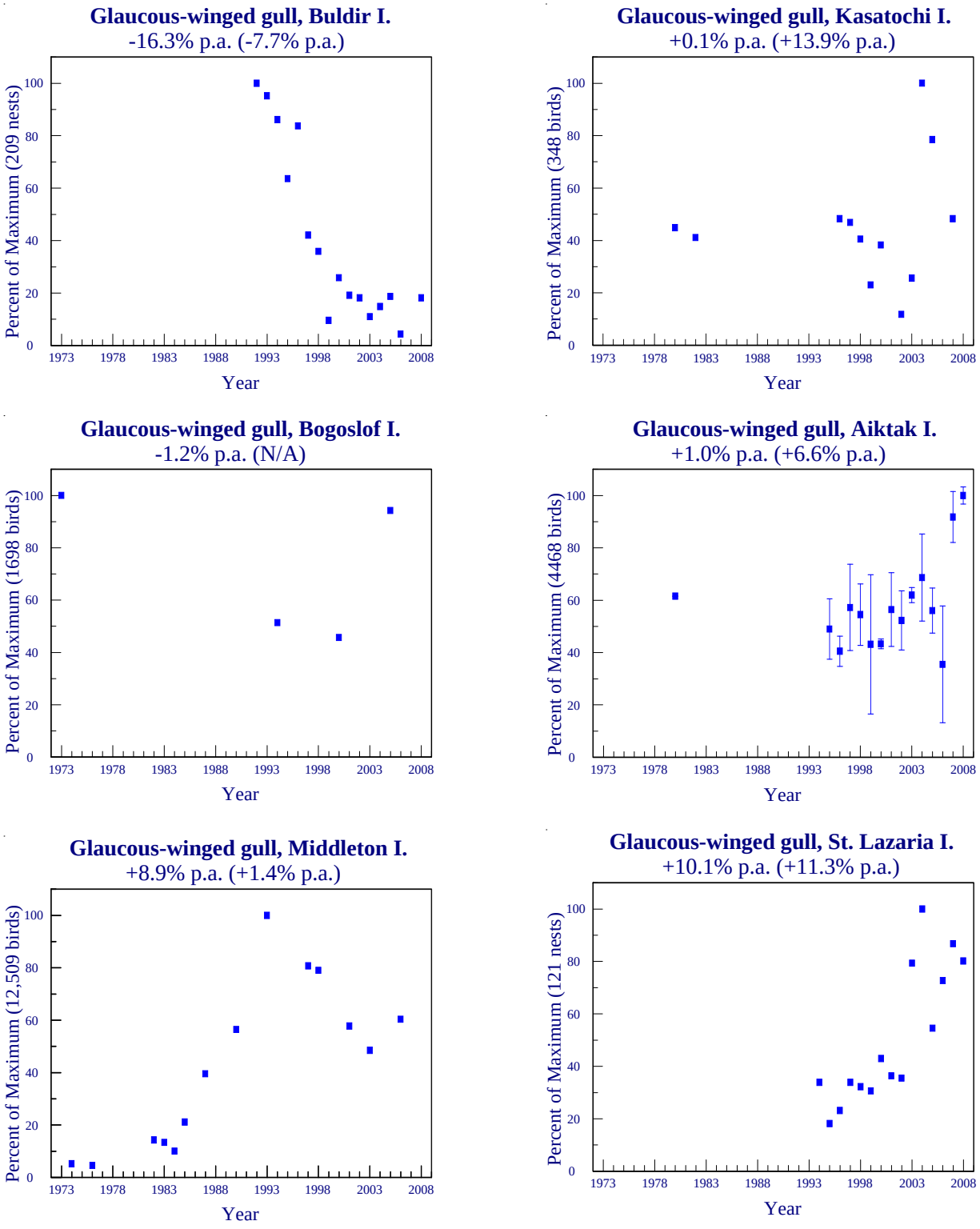

Figure 16. Trends in populations of glaucous-winged gulls at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (1999-2008, in parentheses). “N/A” indicates that insufficient data were available.

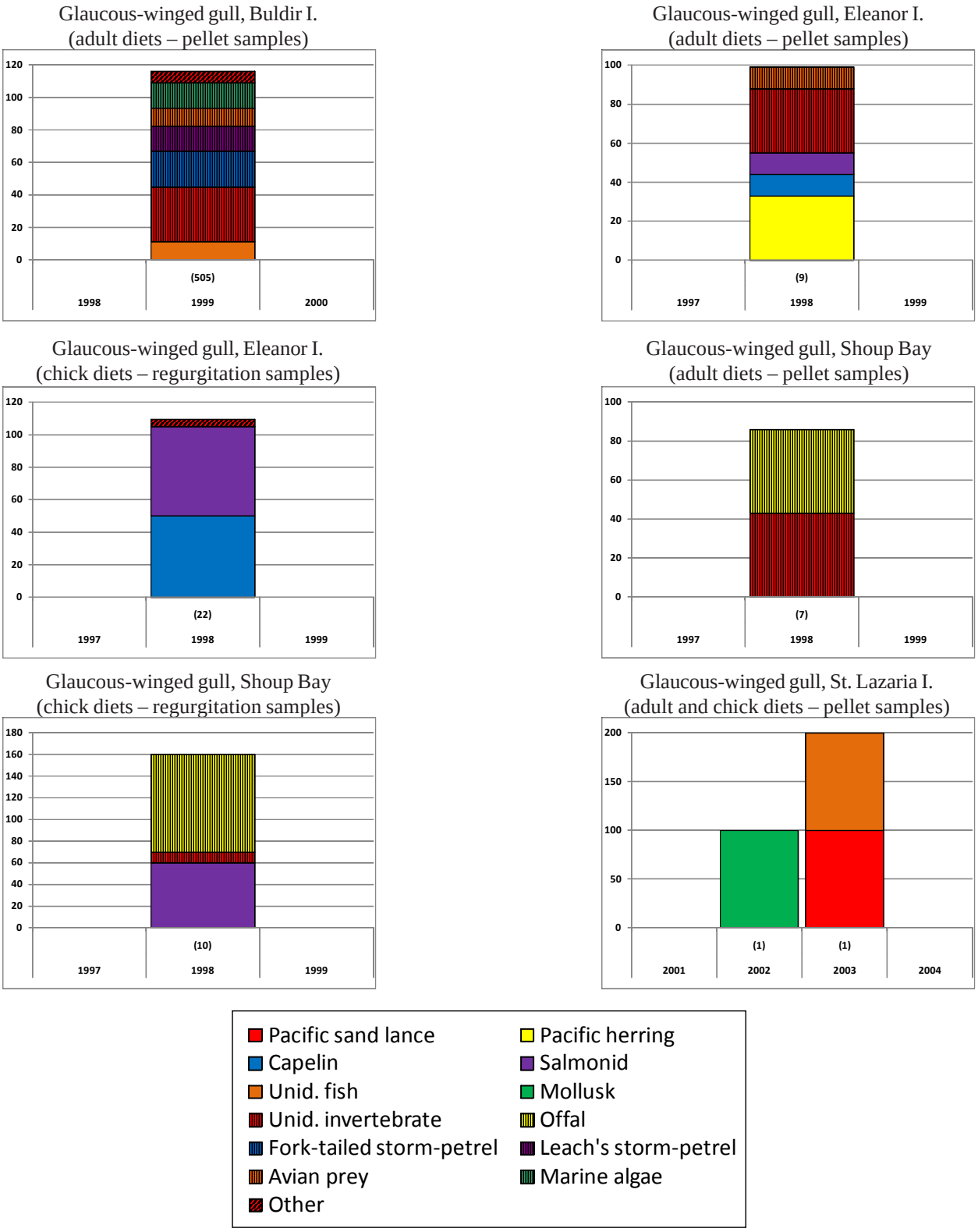

Figure 17. Diets of glaucous-winged gulls at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

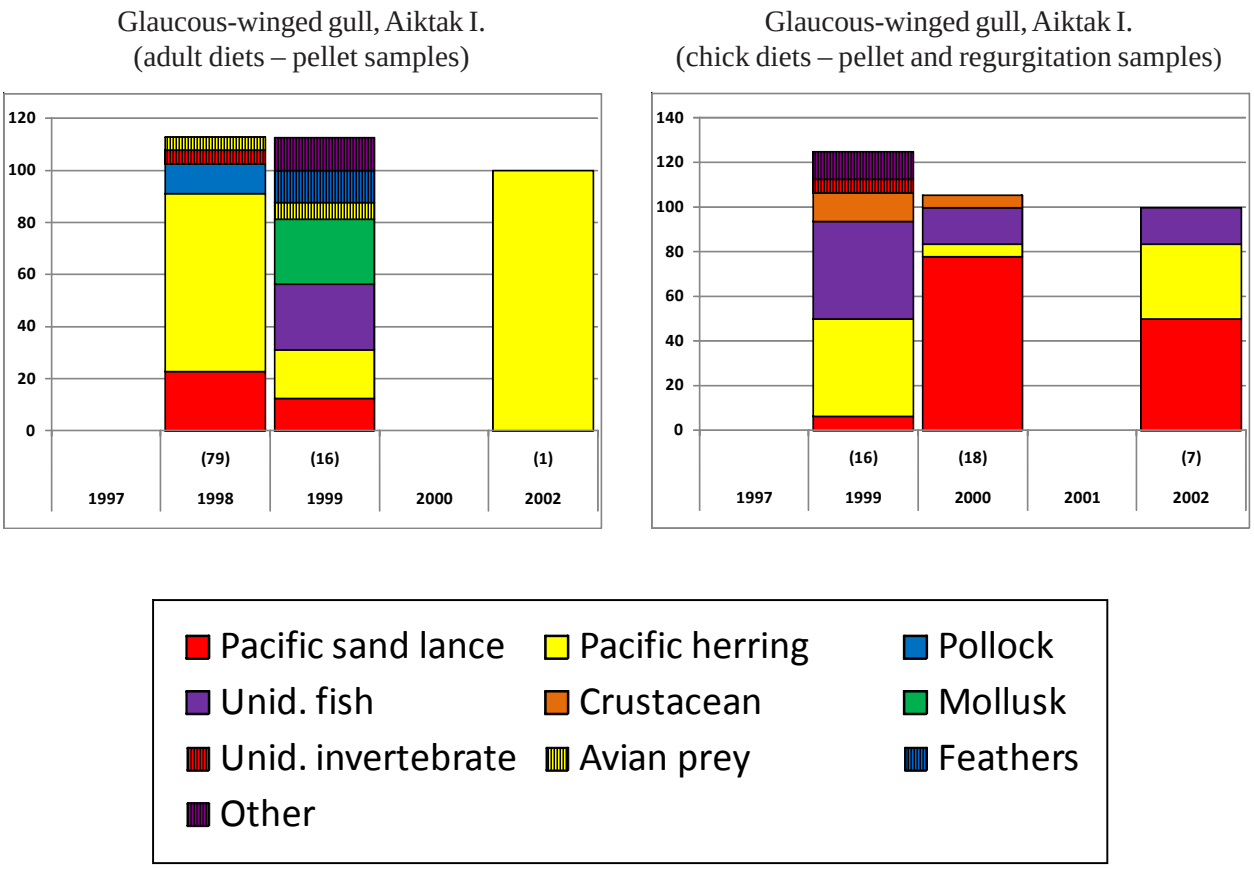

Figure 17 (continued). Diets of glaucous-winged gulls at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Black-legged kittiwake (*Rissa tridactyla*)

Breeding chronology.–In 2008, black-legged kittiwake hatching was early at all monitored colonies (Table 11, Figure 18).

Table 11. Hatching chronology of black-legged kittiwakes at Alaskan sites monitored in 2008.

Site	Median	Mean	Long-term Average	Reference
Bluff	—	12 Jul (N/A[a])[b]	23 Jul[c] (28)[b]	E. Murphy Unpubl. Data
St. Paul I.	—	2 Jul (173)	19 Jul[c] (24)	McClintock et al. 2010
St. George I.	—	29 Jun (104)	19 Jul[c] (26)	Shannon et al. 2010
Buldir I.	—	1 Jul (86)	7 Jul[c] (20)	Freeman et al. 2010
E. Amatuli I.	8 Jul (196)	7 Jul (196)	12 Jul[c] (14)	A. Kettle Unpubl. Data

[a]Not applicable or not reported.
[b]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.
[c]Mean of annual means.

Productivity.–Productivity of black-legged kittiwakes was below average at five of the monitored colonies in 2008, average at one site and above average at three sites (Table 12, Figure 19).

Table 12. Reproductive performance of black-legged kittiwakes at Alaskan sites monitored in 2008.

Site	Chicks Fledged[a]/Nest	No. of Plots	Long-term Average	Reference
C. Lisburne	0.71[b]	2 (207)[c]	0.67 (26)[c]	D. Roseneau Unpubl. Data
St. Lawrence I.	0.00	N/A[d]	0.42 (5)	D. Irons Unpubl. Data
Bluff	0.26[b]	N/A (186)	0.39 (30)	E. Murphy Unpubl. Data
St. Paul I.	0.23	17 (388)	0.30 (28)	McClintock et al. 2010
St. George I.	0.16	6 (179)	0.23 (32)	Shannon et al. 2010
Round I.	0.42	2 (48)	0.21 (9)	Okonek et al. 2008
Buldir I.	0.41	7 (227)	0.14 (20)	Payne 2008
E. Amatuli I.	0.55	11 (531)	0.38 (21)	A. Kettle Unpubl. Data
Pr. Will. Snd.	0.18[b]	N/A (23,271)	0.24 (23)	D. Irons 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 since 1999 at Cape Lisburne, and remained stable during both time periods at Bluff (Figure 20). Hall Island kittiwakes exhibited a declining trend over all years but there were insufficient data to assess trends for the past decade. Kittiwake numbers remained stable over all years, with increasing trends since 1999 at both St.

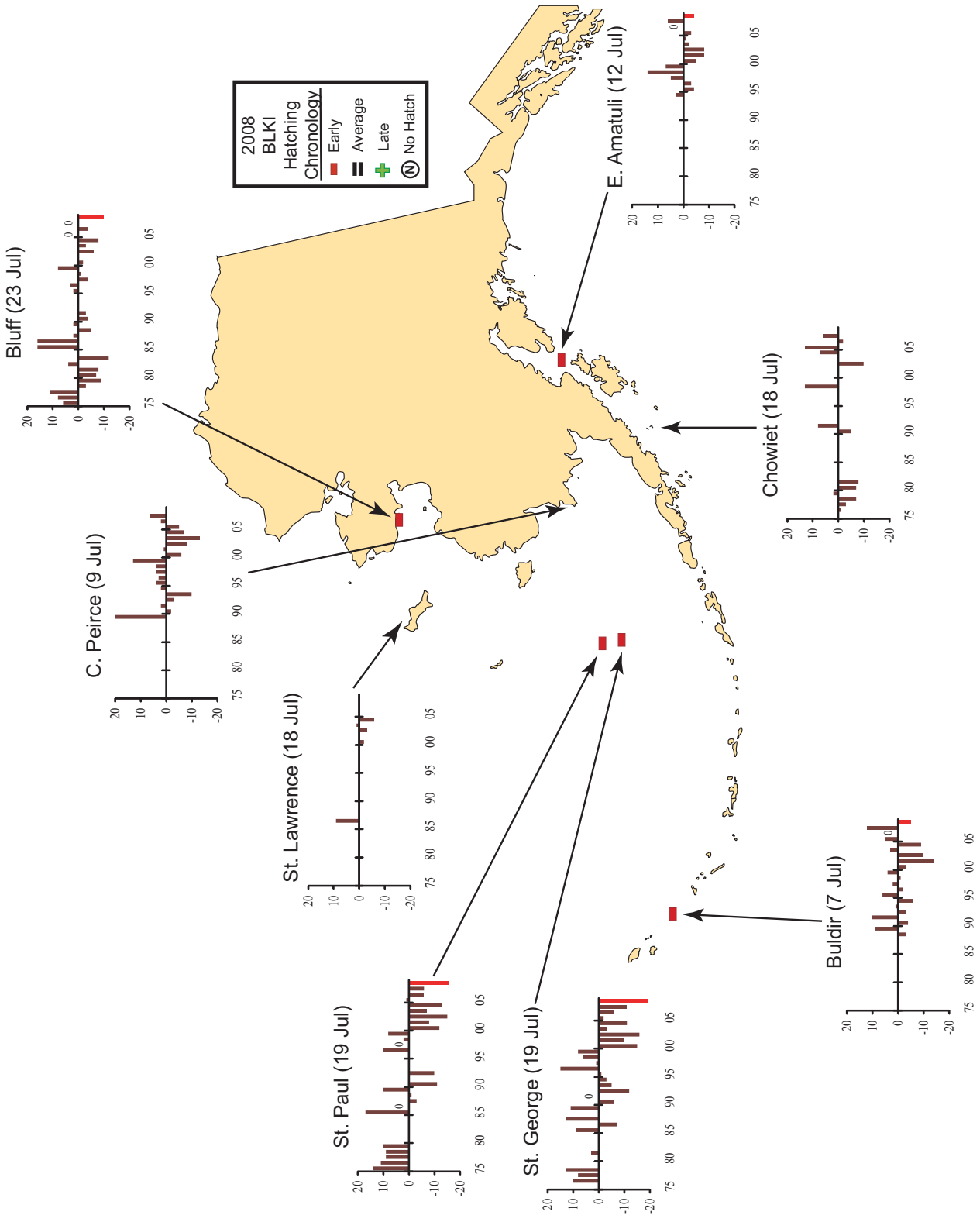

Figure 18. Hatching chronology of black-legged kittiwakes at Alaskan sites monitored in 2008. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

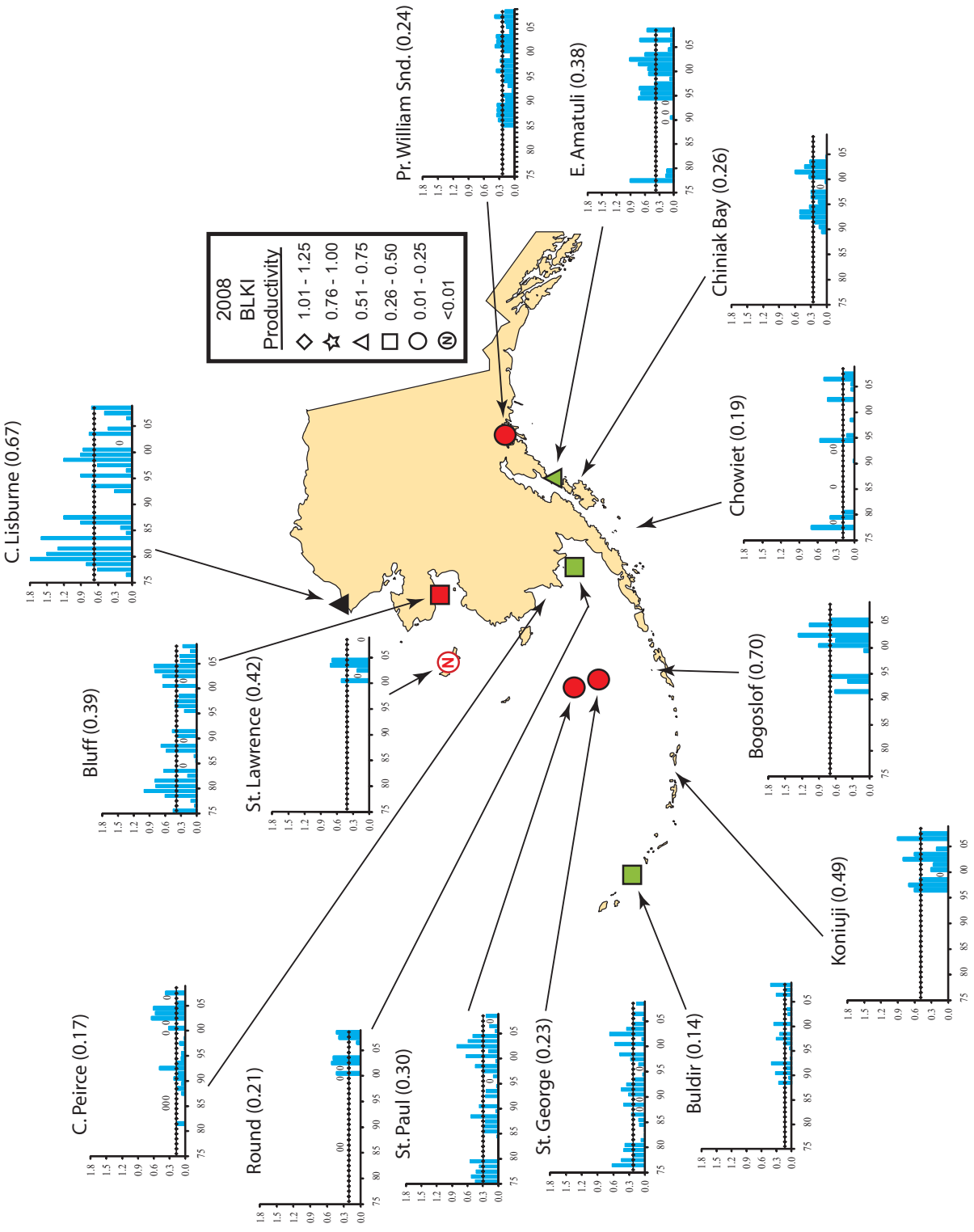

Figure 19. Productivity of black-legged kittiwakes (chicks fledged/nest) at Alaskan sites monitored in 2008. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

Paul and St. George islands. 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 since 1999. No trend was indicated for kittiwakes at Koniuji or Chowiet islands in all years but numbers have increased at both locations recently. Kittiwake numbers remained stable over all years, and since 1999 as well, in Prince William Sound, whereas populations declined during the same 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 21). 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 occurrence of greenling and euphausiids. Bogoslof Island adults and chicks ate predominately myctophids along with lesser amounts of other larval fish and small crustaceans. Shoup Bay kittiwakes ate primarily herring and sand lance. Barren Islands diet samples included capelin and sand lance.

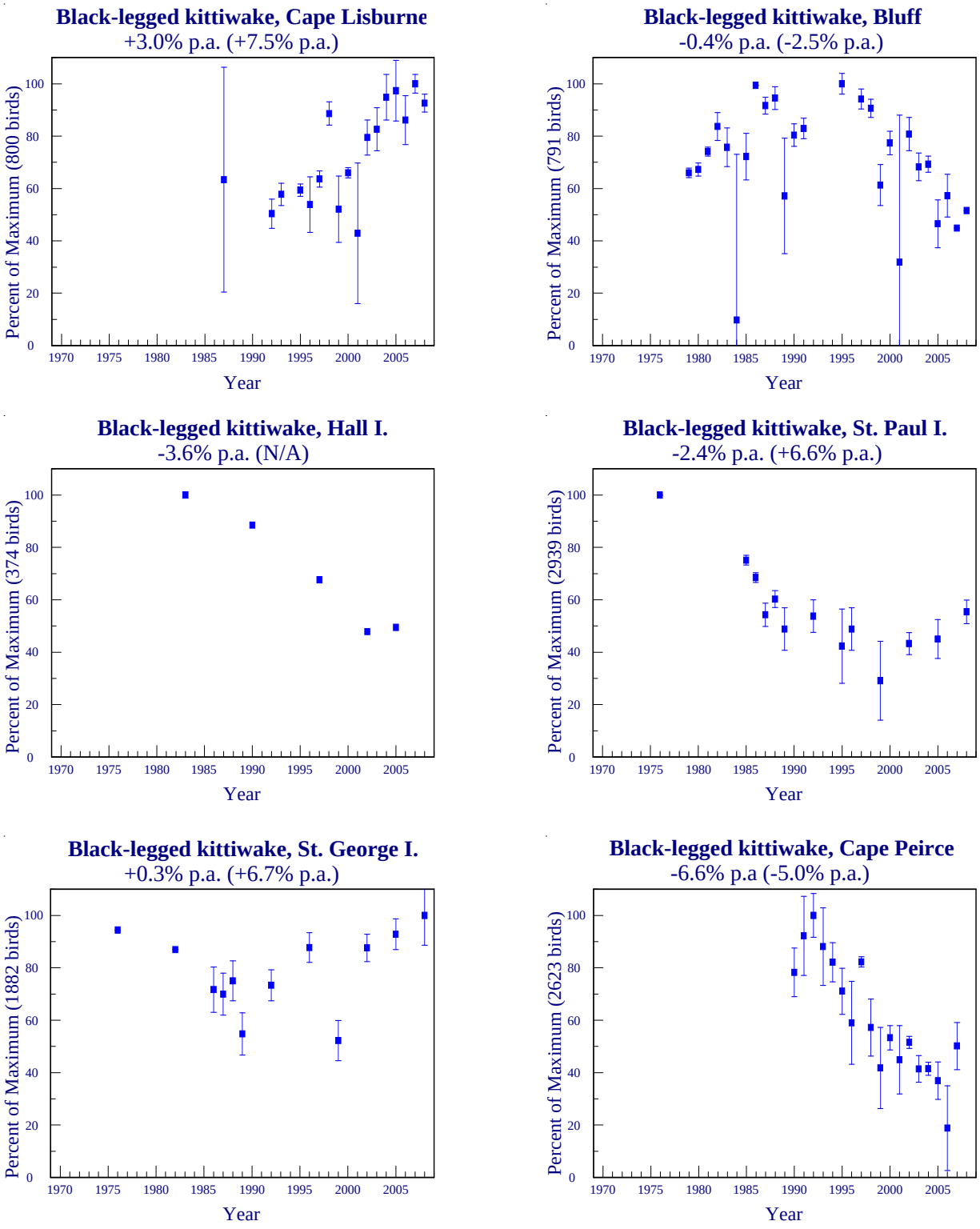

Figure 20. Trends in populations of black-legged kittiwakes at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (1999-2008, in parentheses). “N/A” indicates that insufficient data were available.

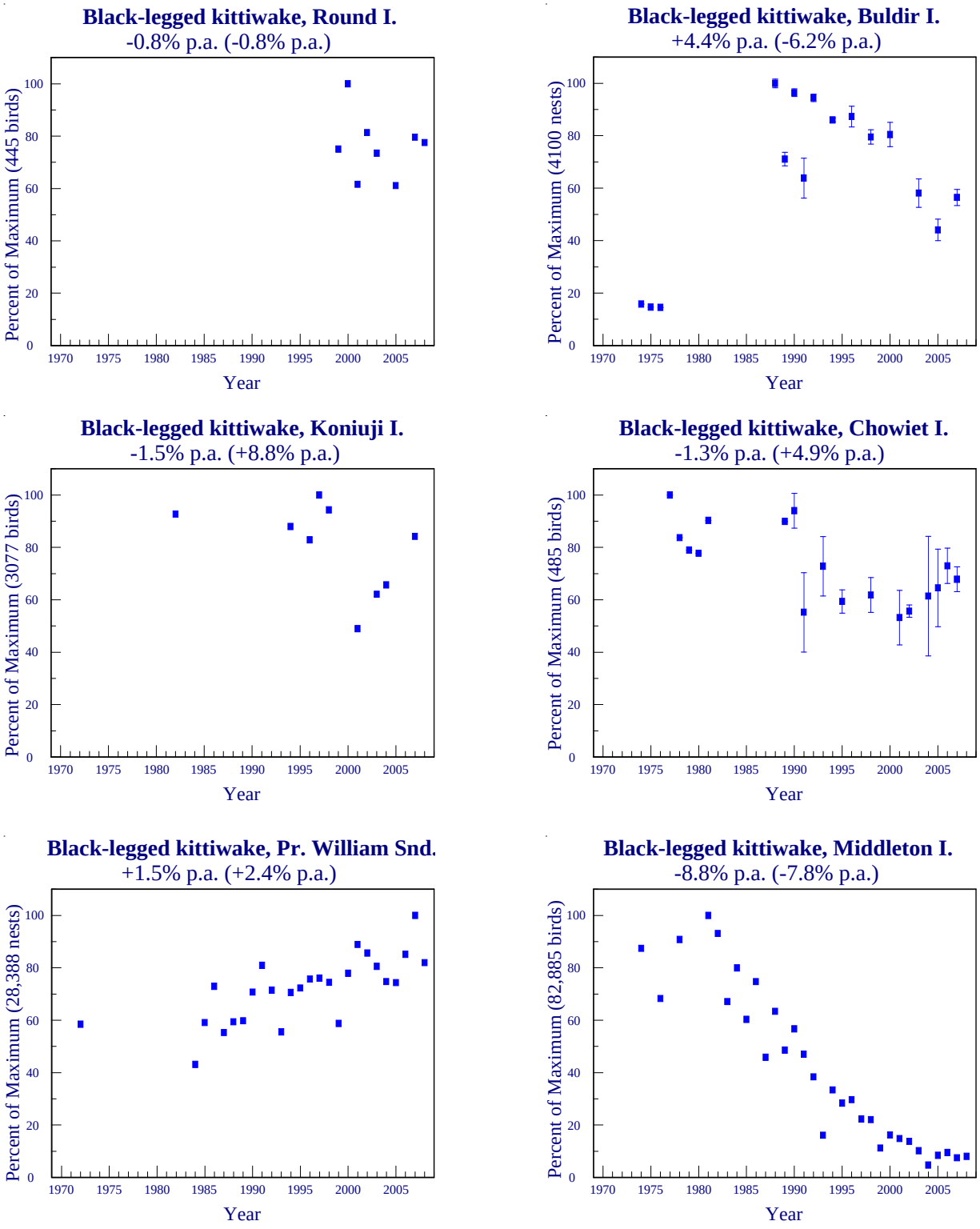

Figure 20 (continued). Trends in populations of black-legged kittiwakes at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (1999-2008, in parentheses). “N/A” indicates that insufficient data were available.

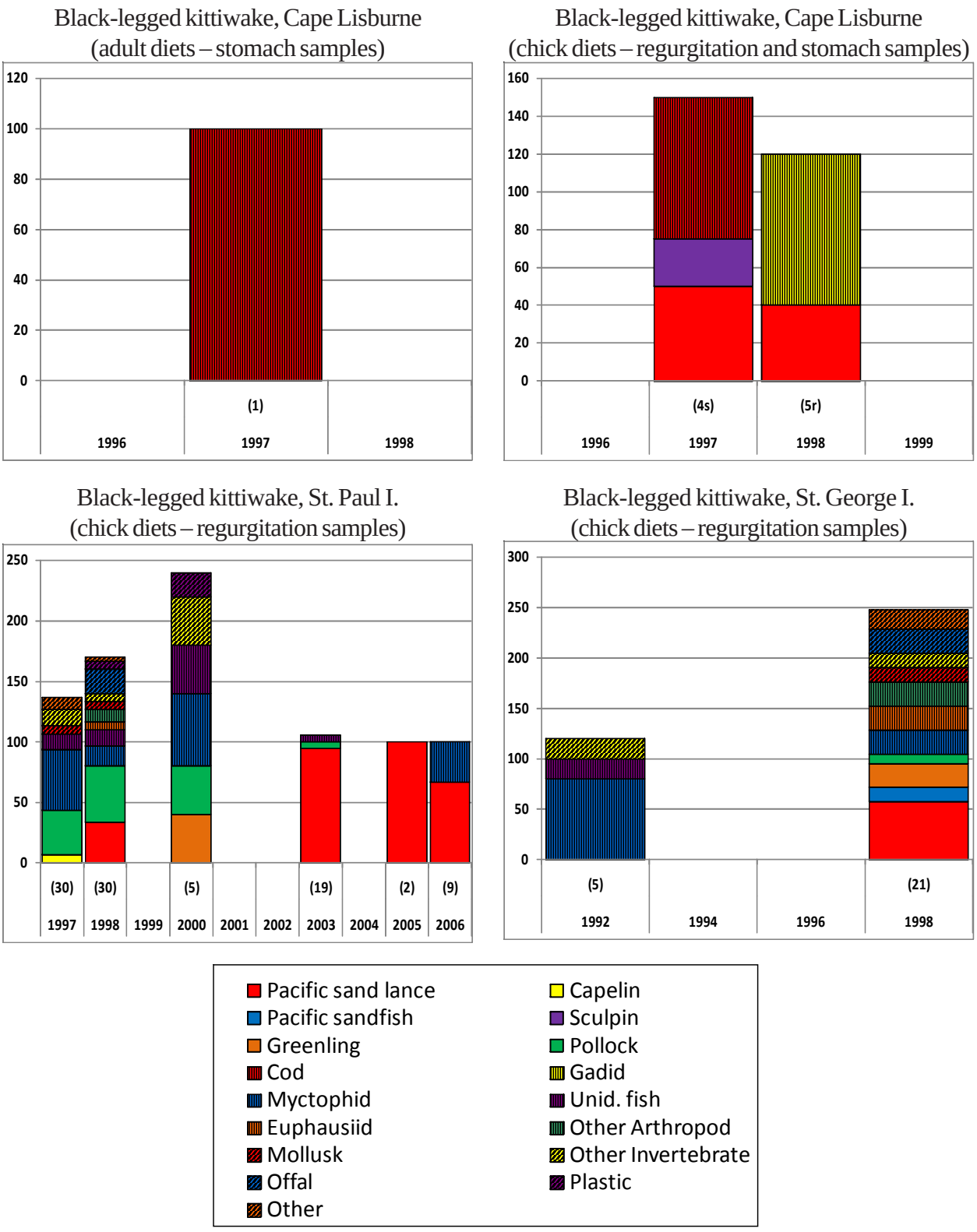

Figure 21. Diets of black-legged kittiwakes at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

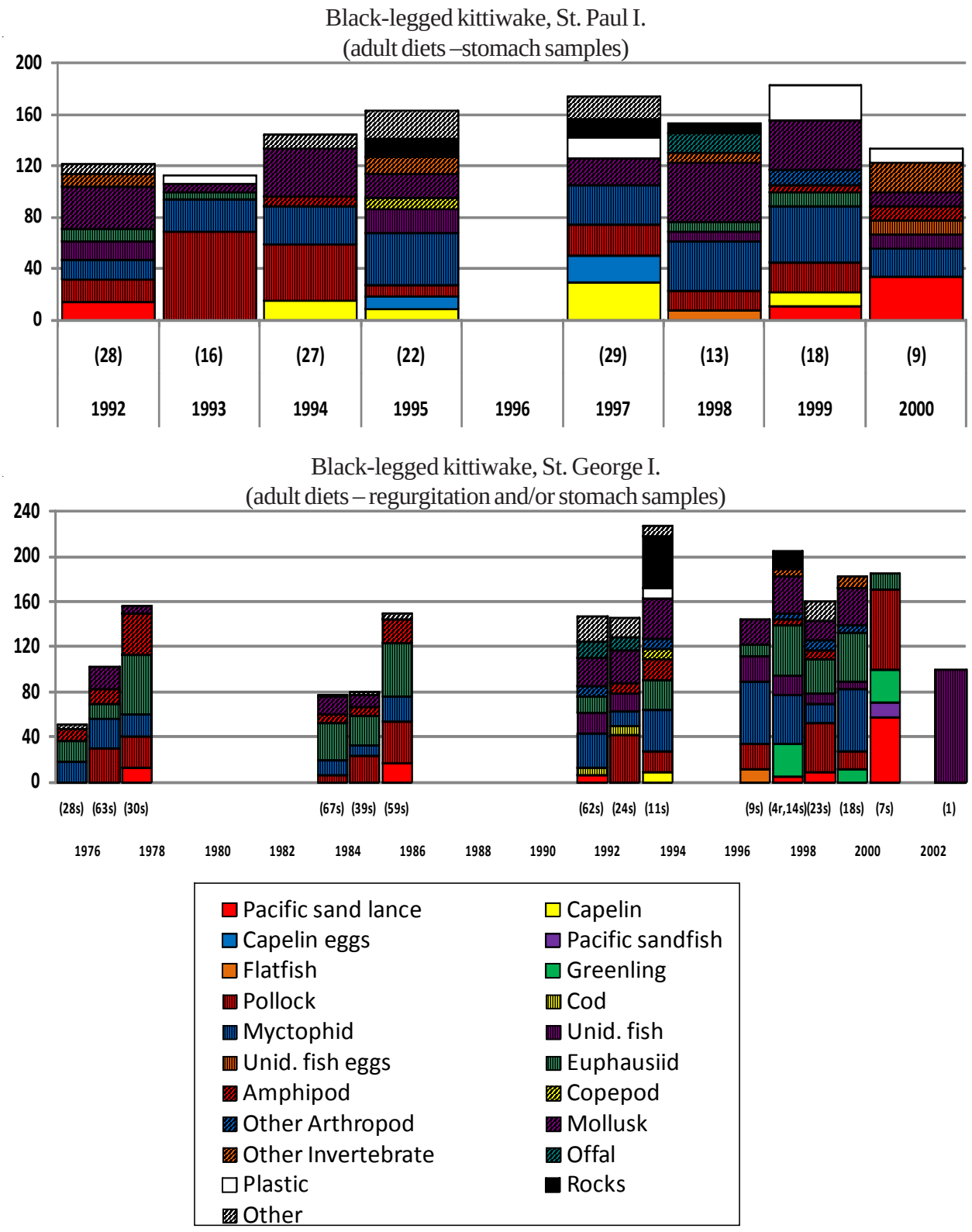

Figure 21 (continued). Diets of black-legged kittiwakes at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

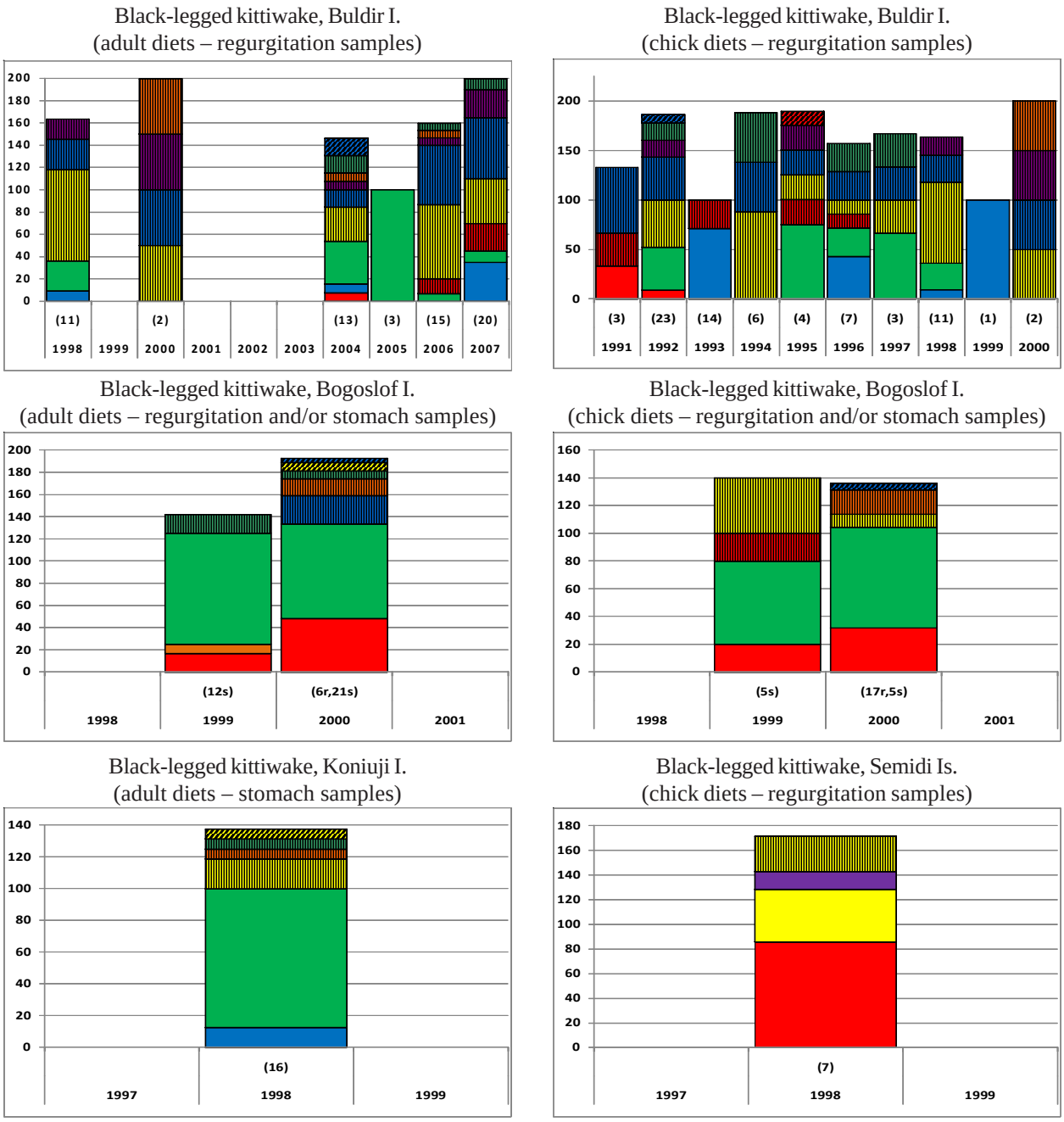

Figure 21 (continued). Diets of black-legged kittiwakes at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

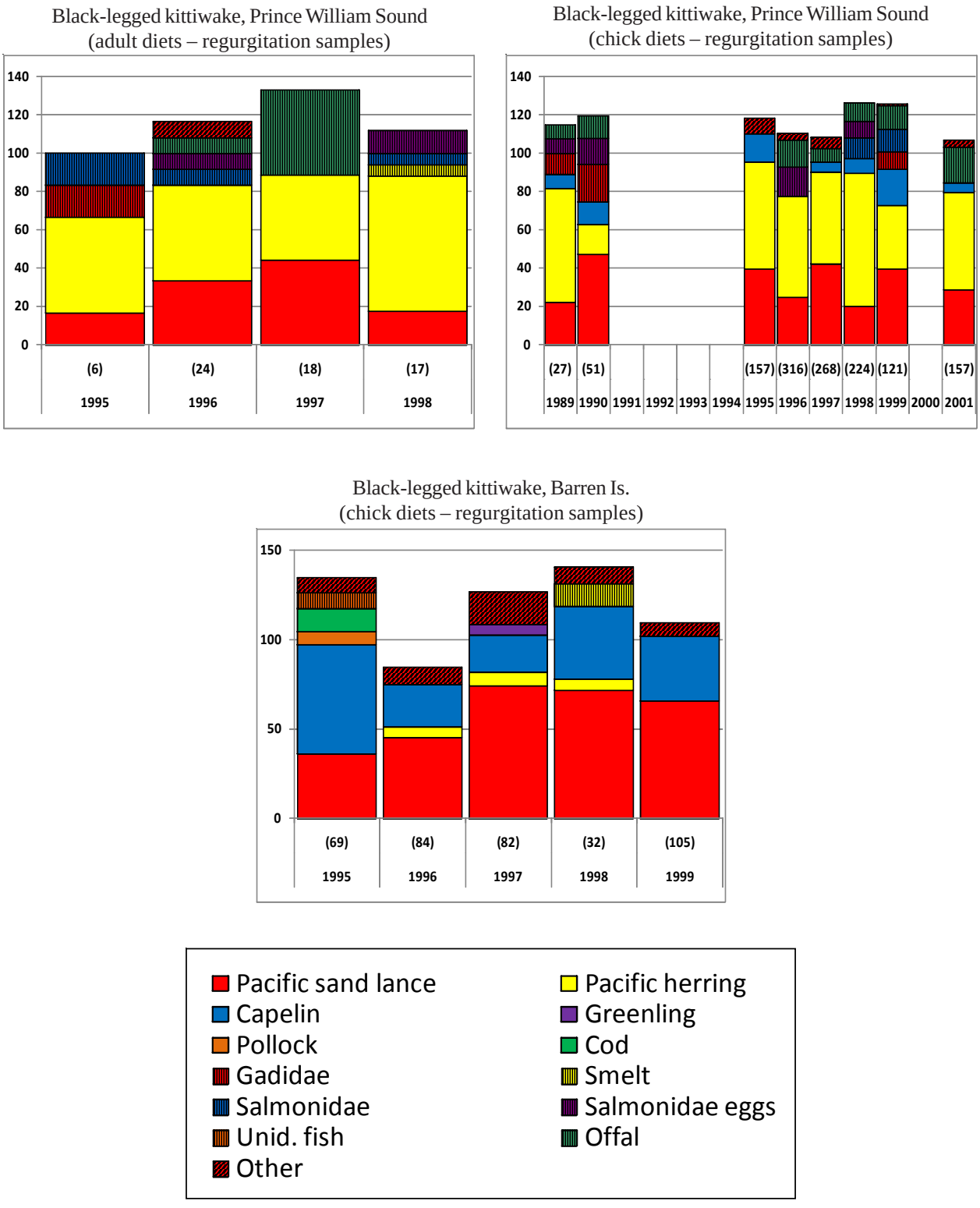

Figure 21 (continued). Diets of black-legged kittiwakes at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Red-legged kittiwake (*Rissa brevirostris*)

Breeding chronology.–Hatch date was early at all monitored colonies in 2008 (Table 13, Figure 22).

Table 13. Hatching chronology of red-legged kittiwakes at Alaskan sites monitored in 2008.

Site	Mean	Long-term Average	Reference
St. Paul I.	6 Jul (17)[a]	21 Jul[b] (23)[a]	McClintock et al. 2010
St. George I.	2 Jul (185)	18 Jul[b] (27)	Shannon et al. 2010
Buldir I.	3 Jul (13)	12 Jul[b] (18)	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 2008, red-legged kittiwakes experienced above average productivity at all three monitored colonies (Table 14, Figure 23).

Table 14. Reproductive performance of red-legged kittiwakes at Alaskan sites monitored in 2008.

Site	Chicks Fledged[a]/Nest	No. of Plots	Long-term Average	Reference
St. Paul I.	0.45	2 (20)[b]	0.23 (28)[b]	McClintock et al. 2010
St. George I.	0.33	10 (321)	0.24 (32)	Shannon et al. 2010
Buldir I.	0.47	N/A[c] (37)	0.16 (20)	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 since 1999, whereas numbers were stable for all years and increasing recently at St. George Island (Figure 24). This species exhibited no trend for either time period at Buldir Island.

Diet.–Diet samples from Bogoslof Island were dominated by myctophids and small invertebrates (Figure 25). 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.

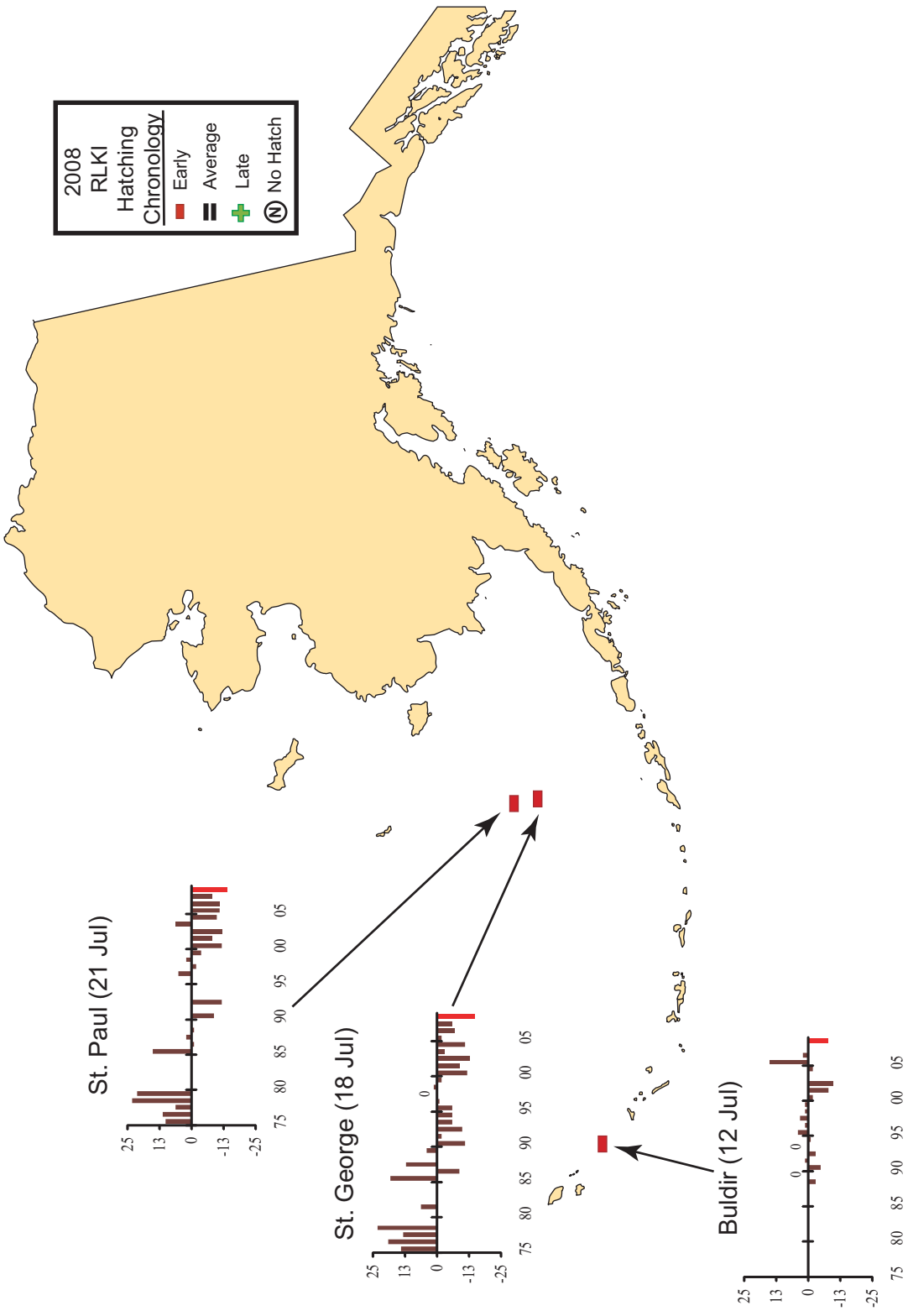

Figure 22. Hatching chronology of red-legged kittiwakes at Alaskan sites monitored in 2008. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

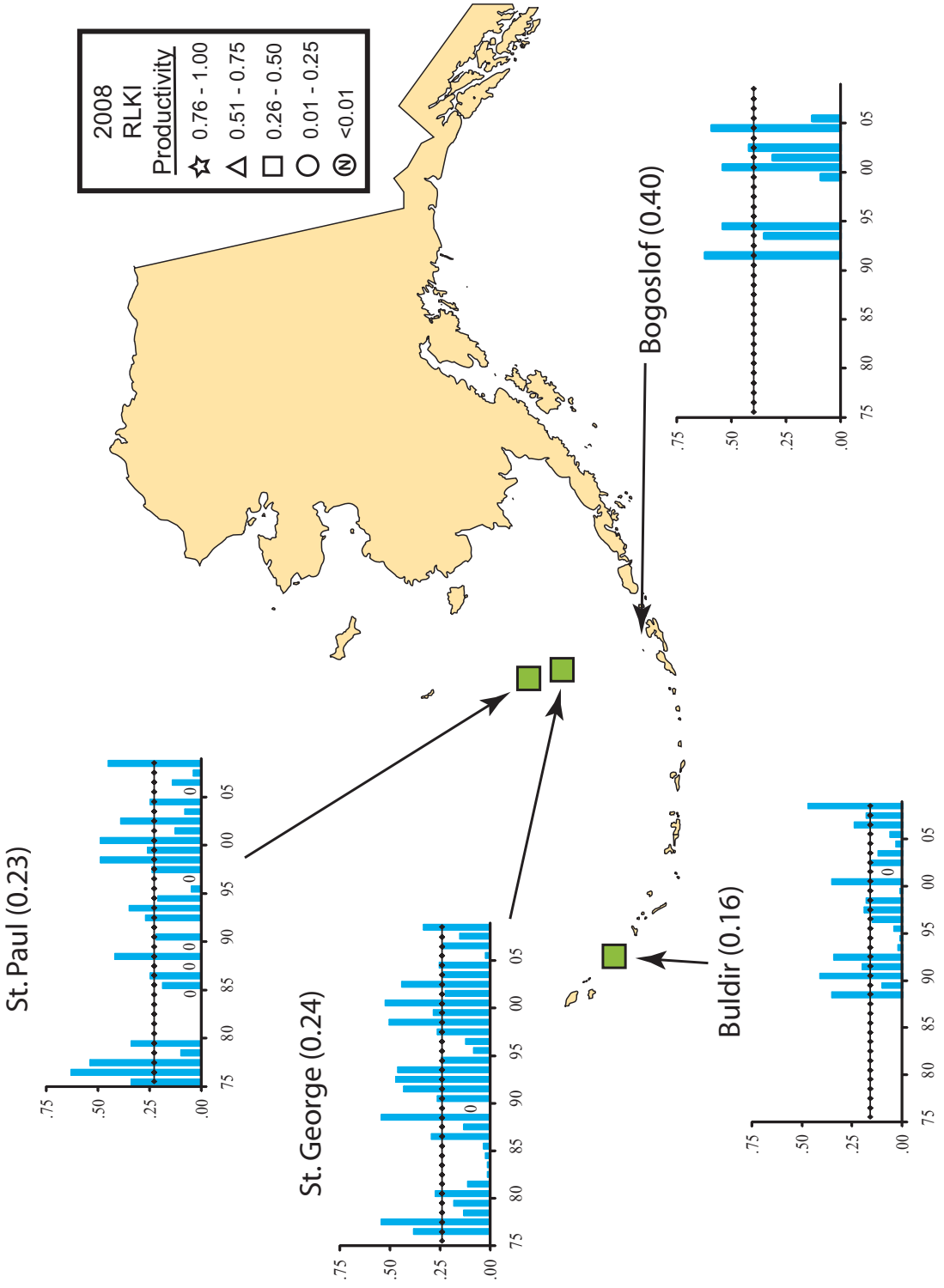

Figure 23. Productivity of red-legged kittiwakes (chicks fledged/nest) at Alaskan sites monitored in 2008. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

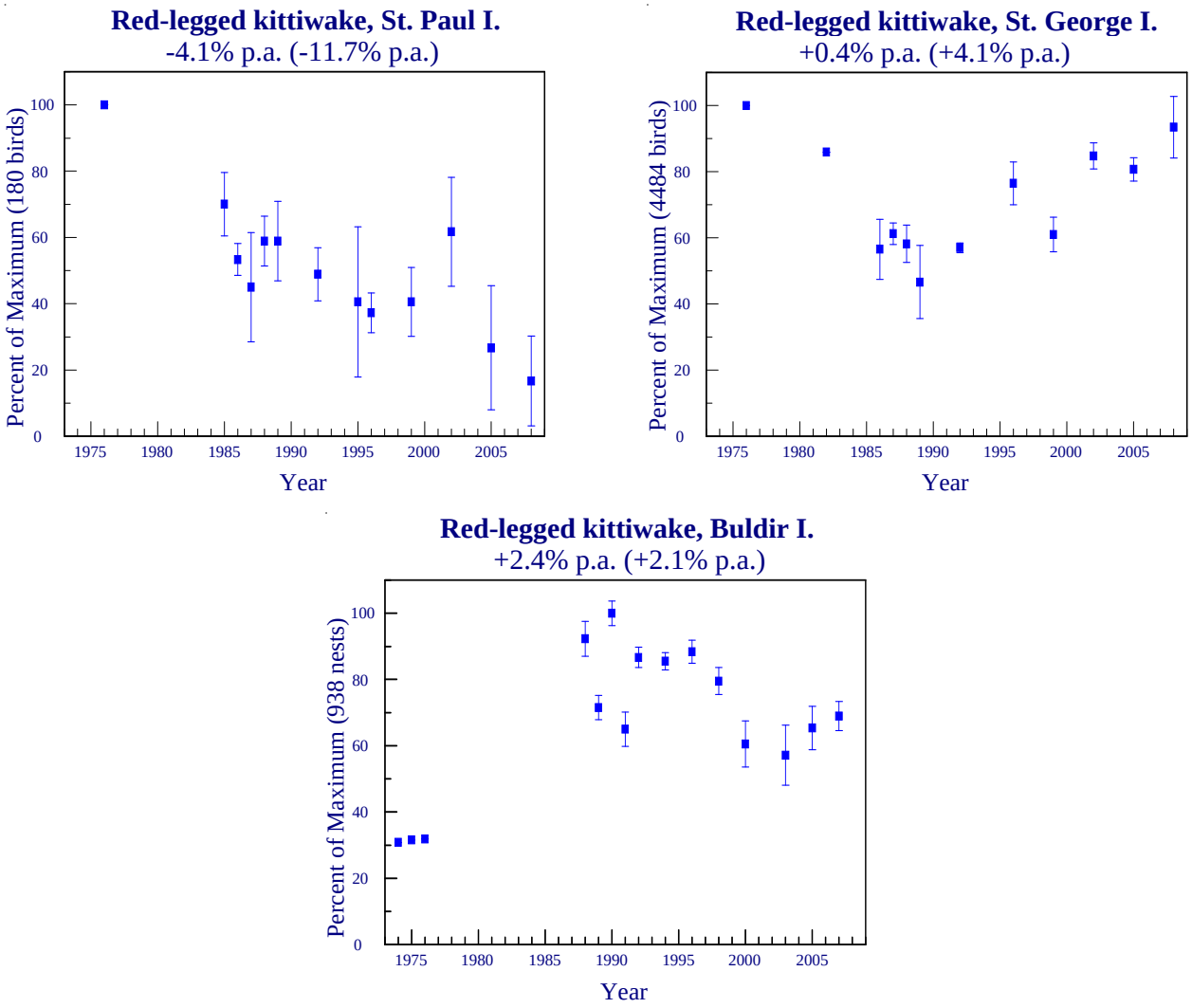

Figure 24. Trends in populations of red-legged kittiwakes at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (1999-2008, in parentheses). “N/A” indicates that insufficient data were available.

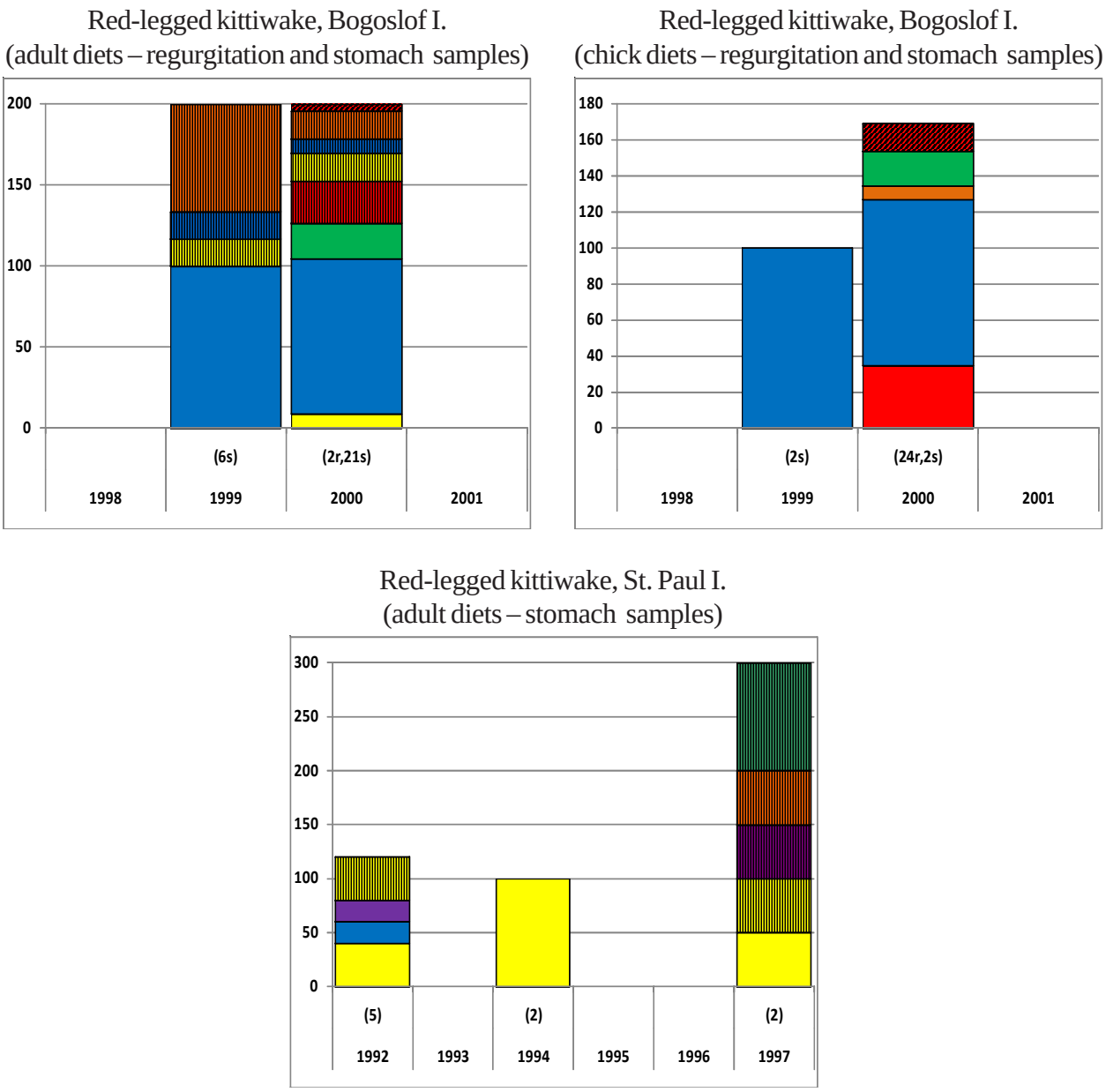

Figure 25. Diets of red-legged kittiwakes at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

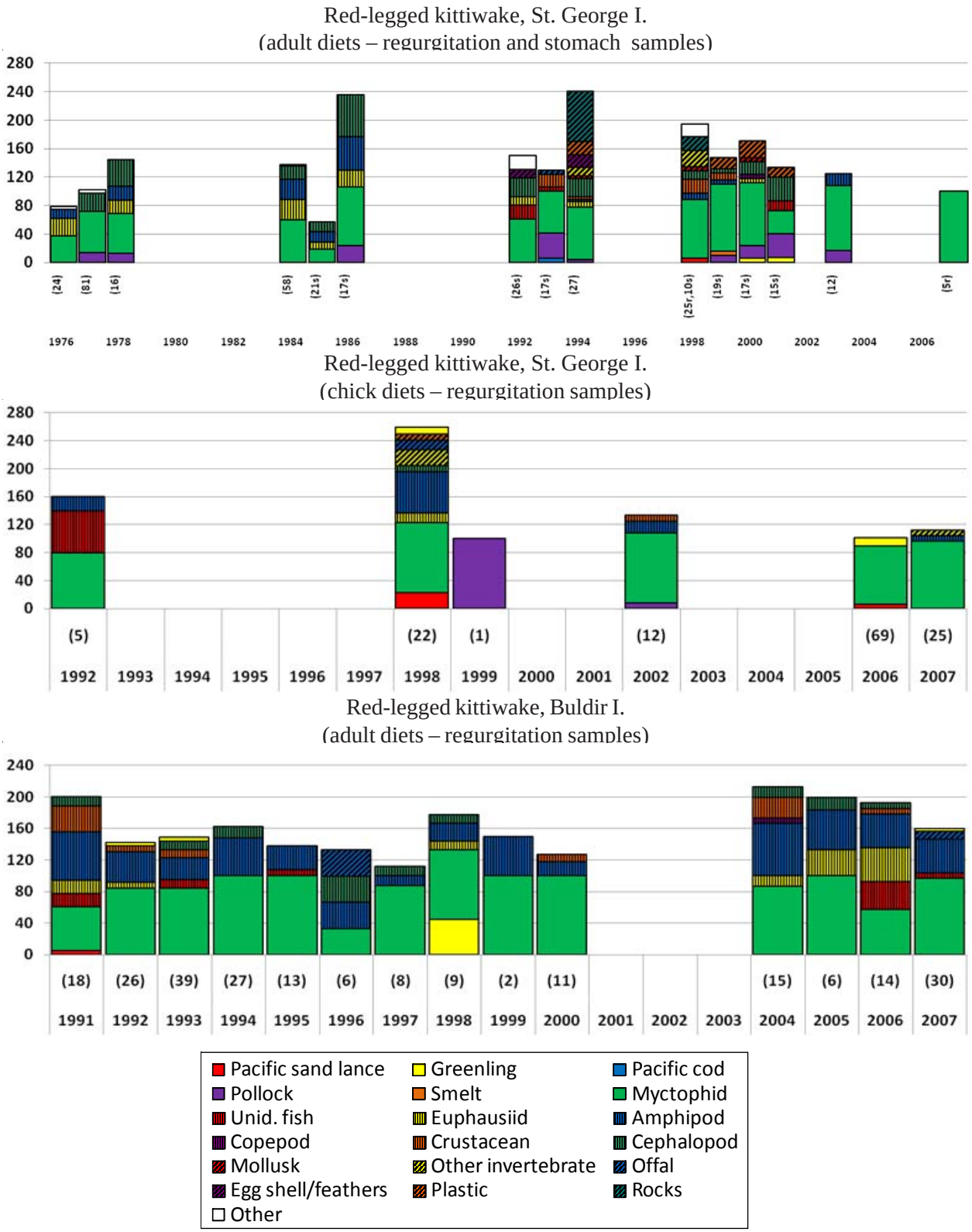

Figure 25 (continued). Diets of red-legged kittiwakes at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Common murre (*Uria aalge*)

Breeding chronology.–Timing of common murre nesting events in 2008 was later than average at East Amatuli Island, and average at all other monitored colonies (Table 15, Figure 26).

Table 15. Hatching chronology of common murres at Alaskan sites monitored in 2008.

Site	Median	Mean	Long-term Average	Reference
St. Paul I.	—	4 Aug (48)[a]	6 Aug[b] (23)[a]	McClintock et al. 2010
St. George I.	—	2 Aug (74)	5 Aug[b] (24)	Shannon et al. 2010
Aiktak I.	—	12 Aug (7)	13 Aug[b] (5)	Sapora et al. 2010
E. Amatuli I.	11 Aug (94)	14 Aug (94)	9 Aug[b] (15)	A. Kettle Unpubl. Data
St. Lazaria I.	—	13 Aug (42)	13 Aug[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.–Common murre productivity was below average at two monitored sites, average at three sites and above average at two sites in 2008 (Table 16, Figure 27).

Table 16. Reproductive performance of common murres at Alaskan sites monitored in 2008.

Site	Chicks Fledged/ Nest Site[a]	No. of Plots	Long-term Average	Reference
St. Lawrence I.	0.50	N/A[b] (N/A)[c]	0.47 (6)[c]	D. Irons Unpubl. Data
St. Paul I.	0.38	8 (133)	0.51 (21)	McClintock et al. 2010
St. George I.	0.41	6 (165)	0.50 (23)	Shannon et al. 2010
Round I.	0.54	3 (52)	0.21 (7)	Okonek et al. 2008
Buldir I.	0.57	N/A (7)	0.44 (11)	Freeman et al. 2010
Aiktak I.	0.18	N/A (17)	0.28 (12)	Sapora et al. 2010
St. Lazaria I.	0.58	N/A (72)	0.52 (14)	L. Slater Unpubl. Data

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

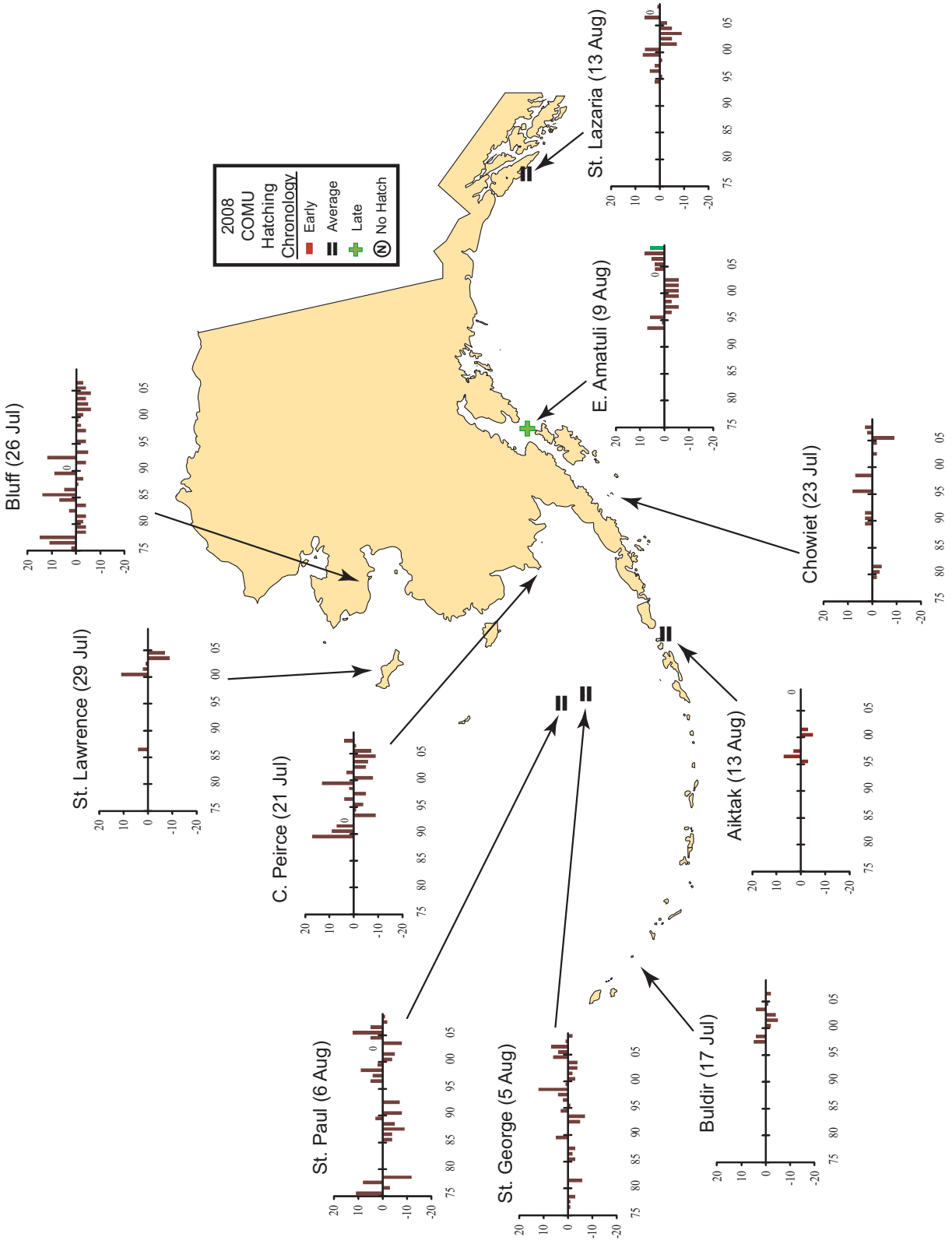

Figure 26. Hatching chronology of common murres at Alaskan sites monitored in 2008. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

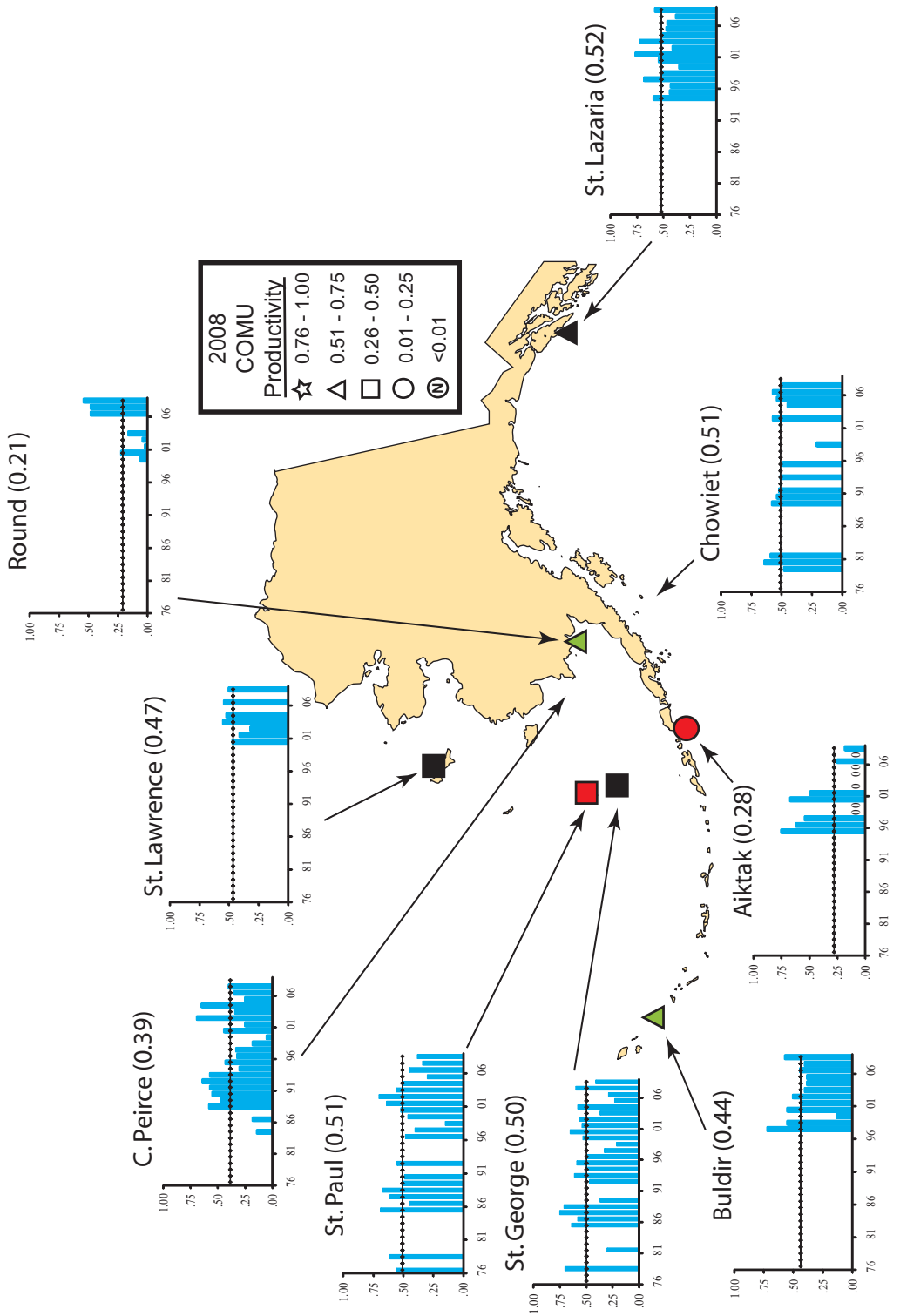

Figure 27. Productivity of common murres (chicks fledged/nest site) at Alaskan sites monitored in 2008. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current 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 since 1999 (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 all years at St. Paul Island but populations were stable during the last decade. The pattern was just the opposite at St. George Island, stable overall with a downward trend in recent years. At Cape Peirce, this species exhibited a decline when all years were included and stable numbers since 1999. Common murres increased at Round Island, from which we have data only since 1999.

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 in the last decade. 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 since 1999. No overall trend was evident at Chowiet Island but murre numbers increased there during the last decade. Middleton Island murre populations, on the other hand, showed a decline both in the long term and 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.

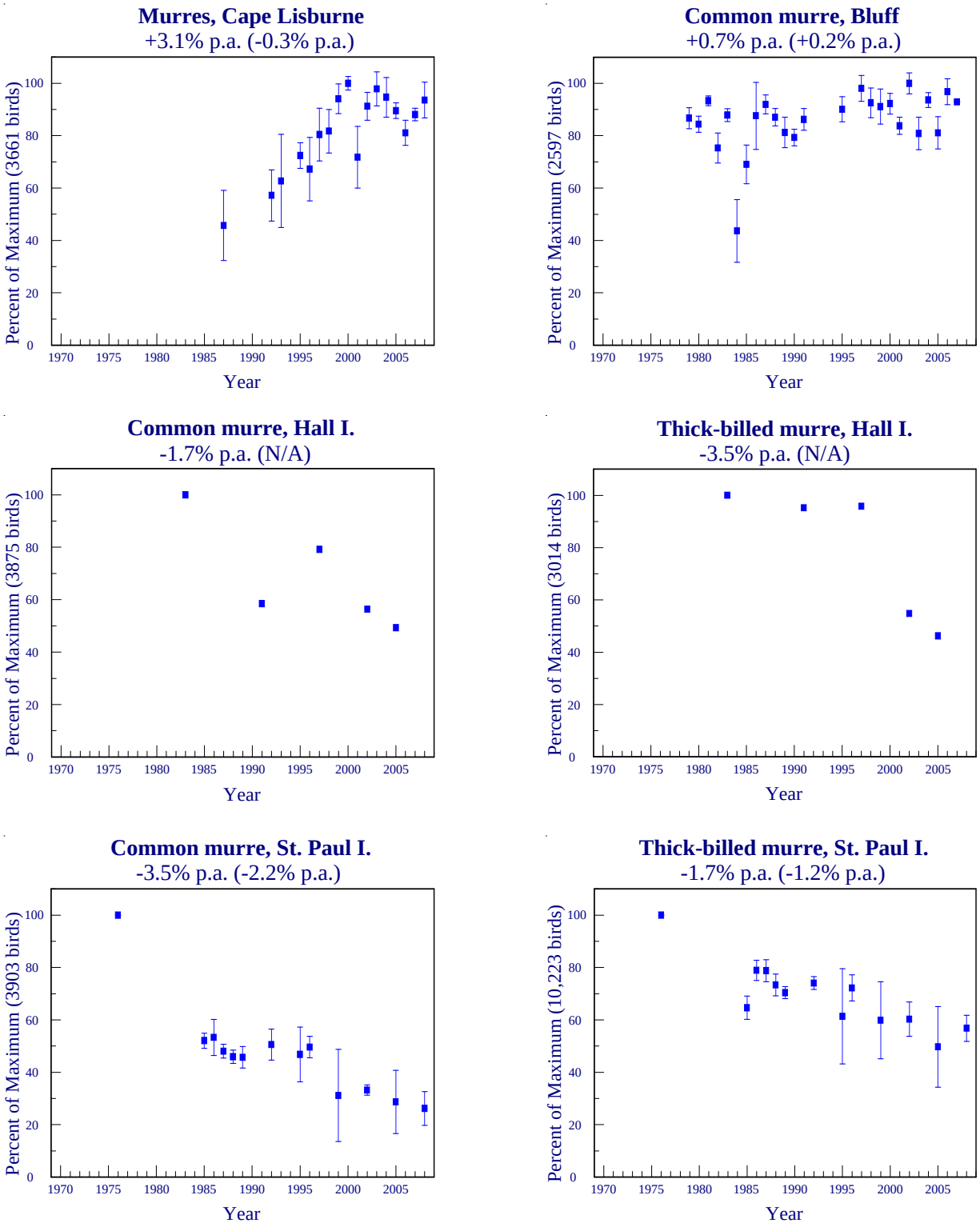

Figure 28. Trends in populations of murres at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (1999-2008, in parentheses). “N/A” indicates that insufficient data were available.

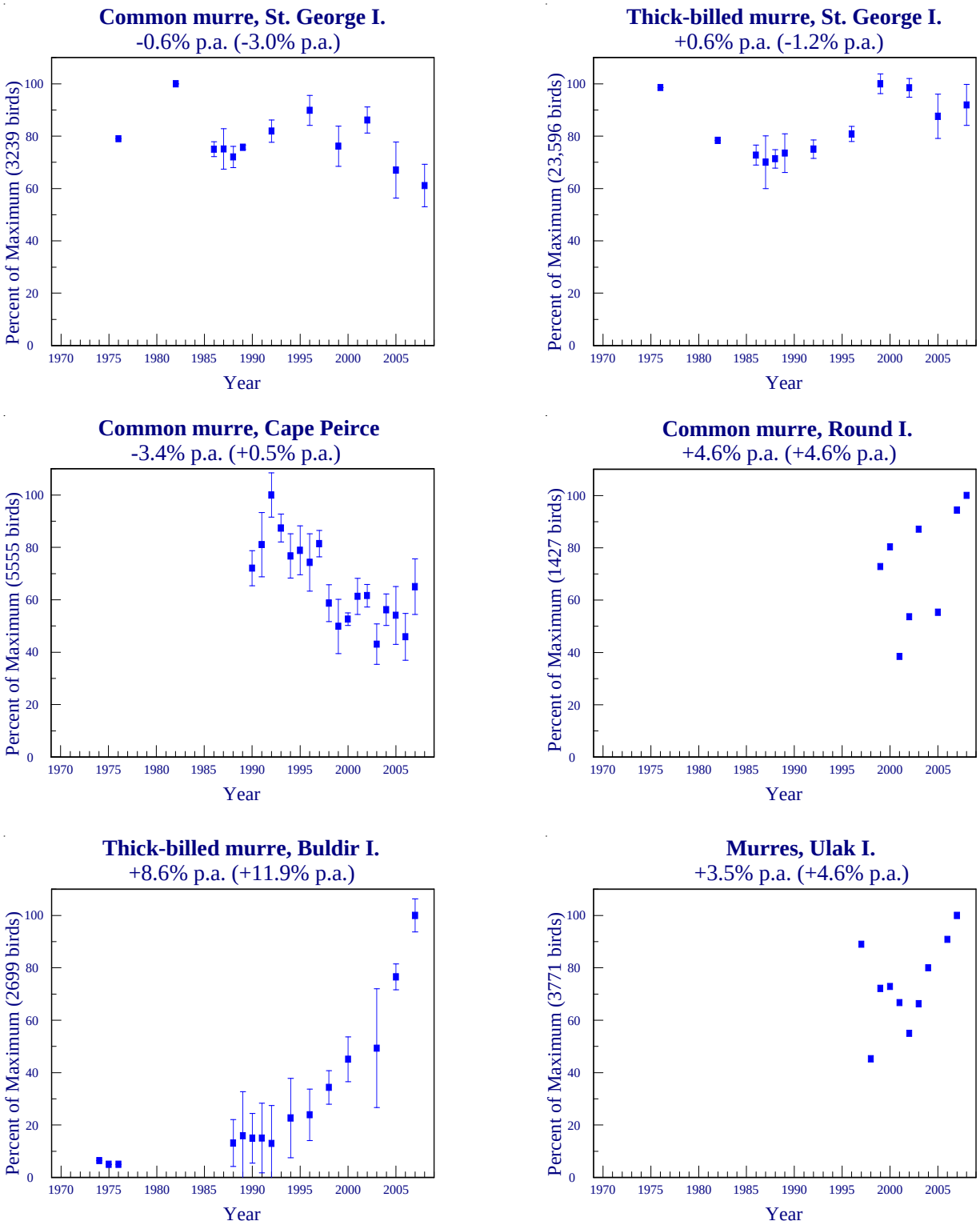

Figure 28 (continued). Trends in populations of murres at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (1999-2008, in parentheses). “N/A” indicates that insufficient data were available.

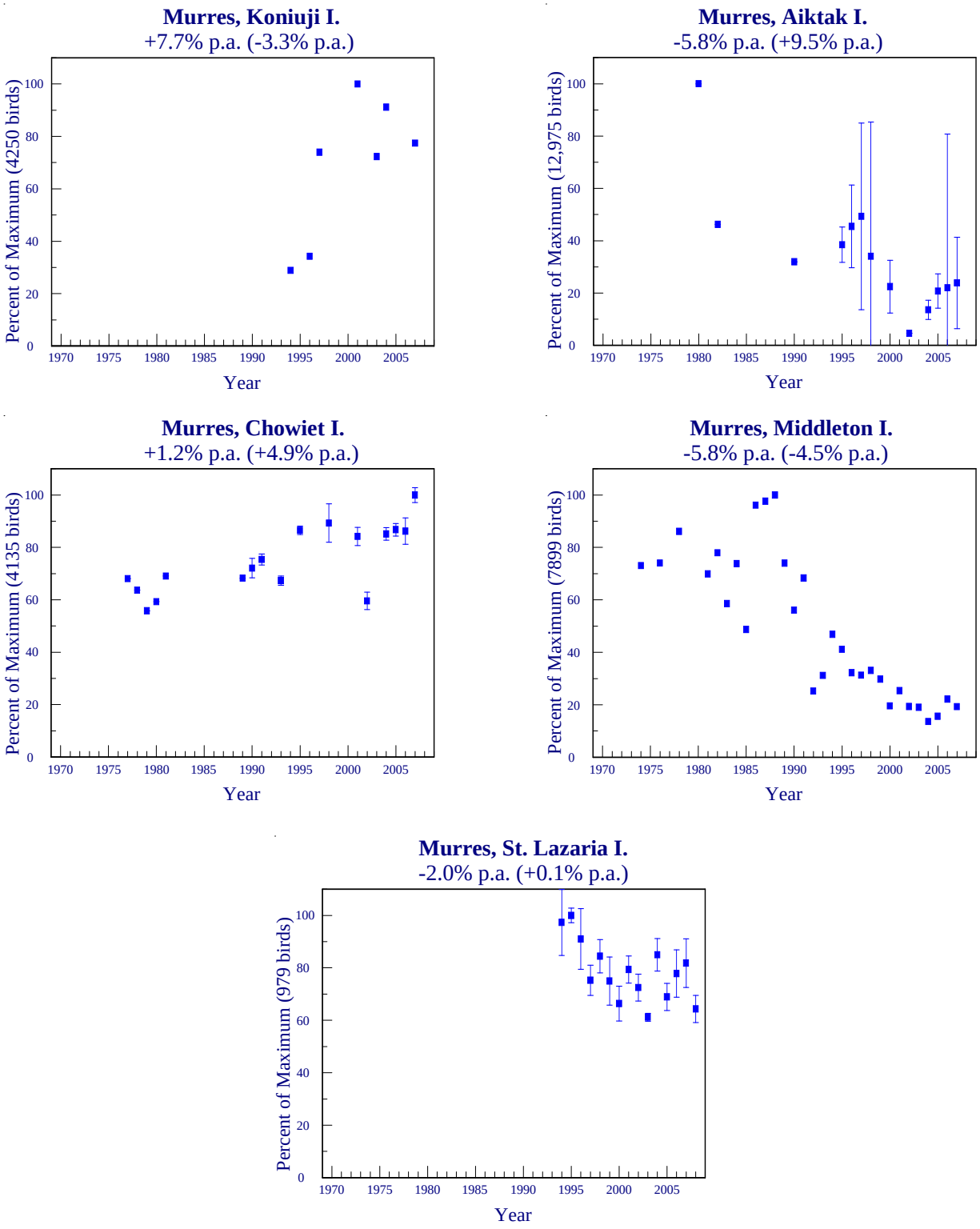

Figure 28 (continued). Trends in populations of murres at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (1999-2008, in parentheses). “N/A” indicates that insufficient data were available.

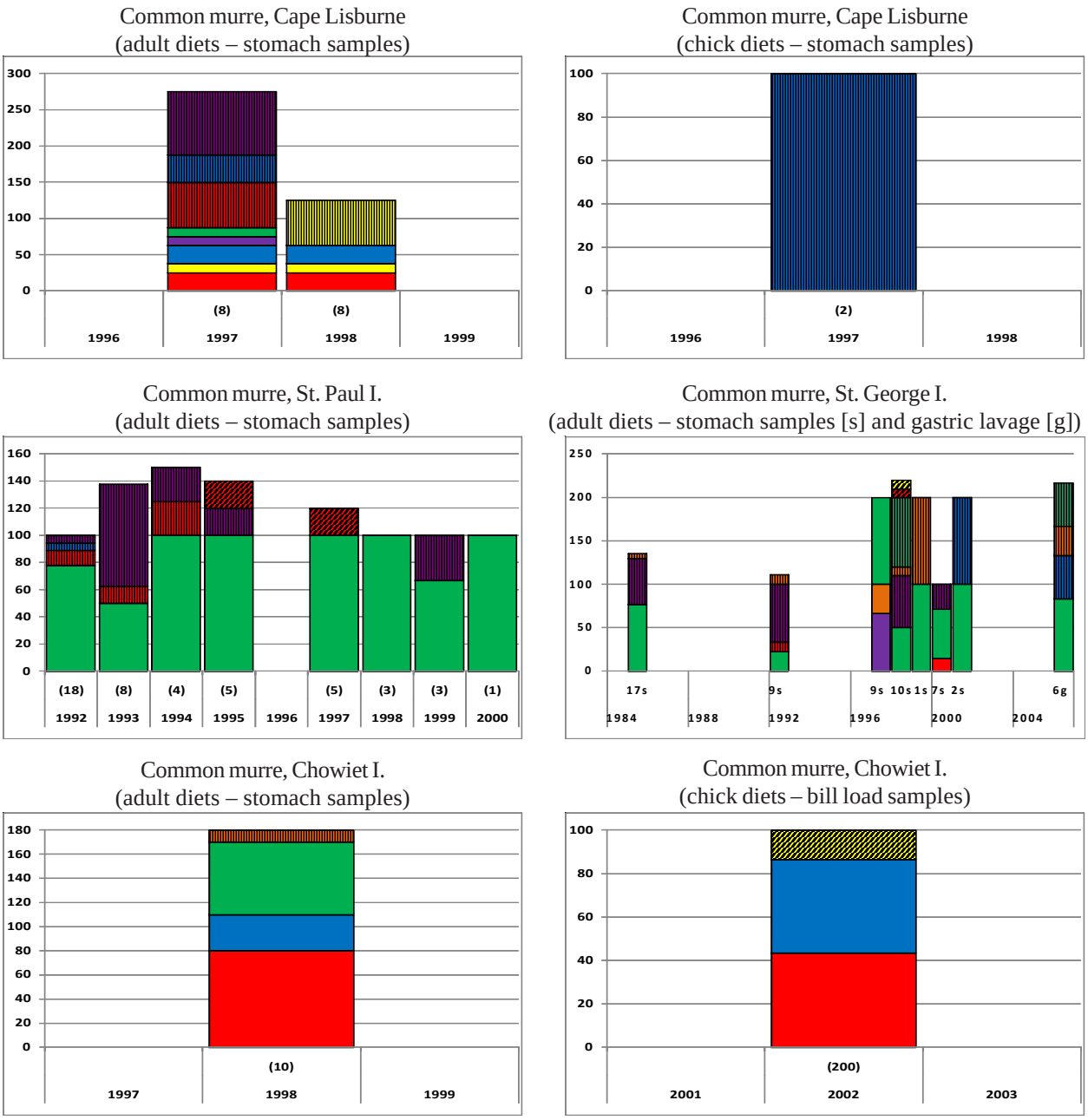

Figure 29. Diets of common murres at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

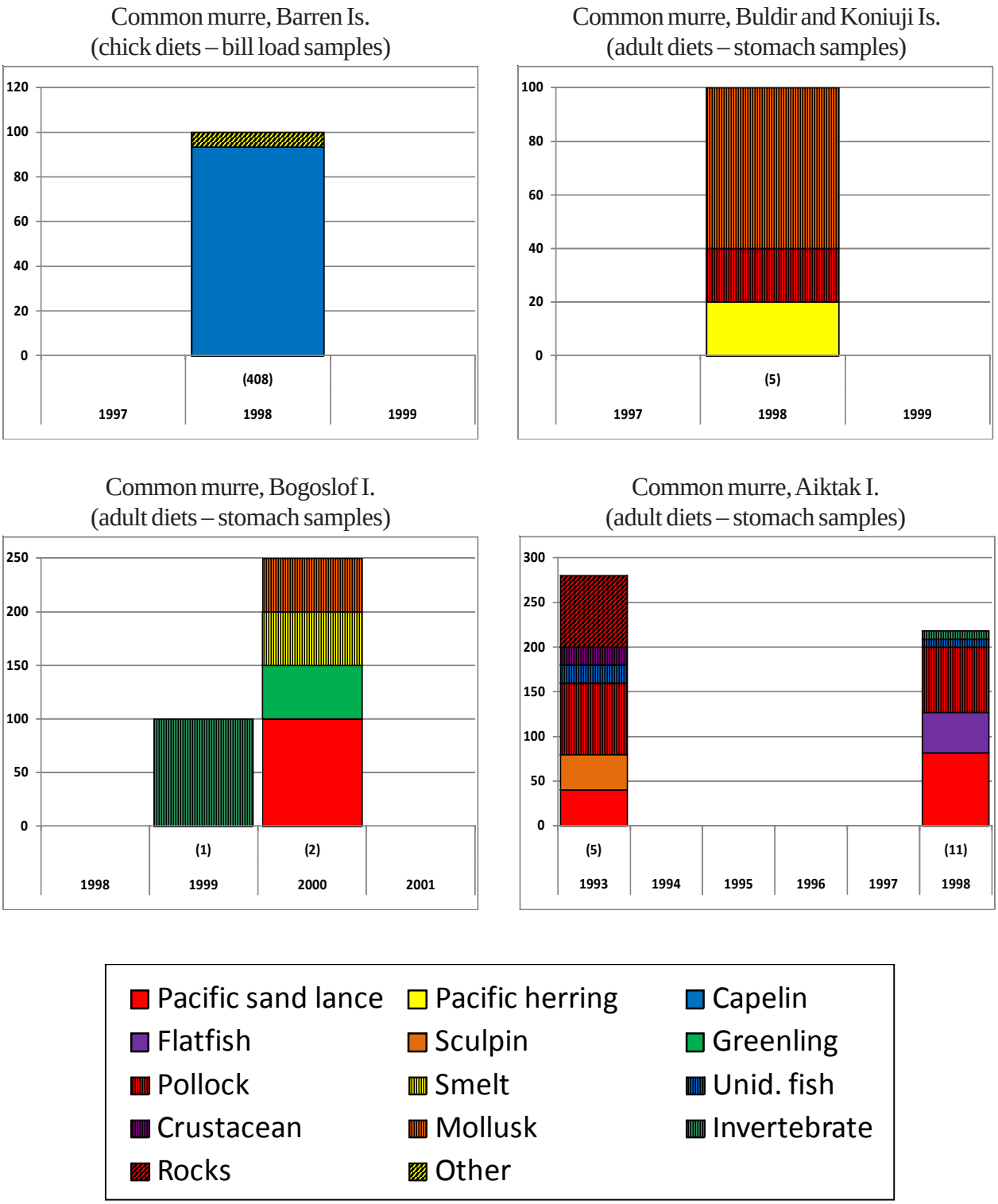

Figure 29 (continued). Diets of common murres at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Thick-billed murre (*Uria lomvia*)

Breeding chronology.–In 2008, thick-billed murre chick hatching was earlier than average at St. George Island, late at St. Lazaria Island, and average at St. Paul and Buldir islands (Table 17, Figure 30).

Table 17. Hatching chronology of thick-billed murres at Alaskan sites monitored in 2008.

Site	Mean	Long-term Average	Reference
St. Paul I.	2 Aug (113)[a]	6 Aug[b] (23)[a]	McClintock et al. 2010
St. George I.	27 Jul (172)	1 Aug[b] (26)	Shannon et al. 2010
Buldir I.	19 Jul (99)	18 Jul[b] (20)	Freeman et al. 2010
St. Lazaria I.	13 Aug (22)	10 Aug[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.–Thick-billed murre rates of success in 2008 were above average at Aiktak Island, average at four colonies and below average at St. Paul Island (Table 18, Figure31).

Table 18. Reproductive performance of thick-billed murres at Alaskan sites monitored in 2008.

Site	Chicks Fledged/ Nest Site[a]	No. of Plots	Long-term Average	Reference
St. Lawrence I.	0.52	N/A[b] (N/A)[c]	0.49 (6)[c]	D. Irons Unpubl. Data
St. Paul I.	0.35	16 (337)	0.45 (23)	McClintock et al. 2010
St. George I.	0.47	10 (327)	0.52 (27)	Shannon et al. 2010
Buldir I.	0.67	9 (235)	0.65 (20)	Freeman et al. 2010
Aiktak I.	0.33	N/A (6)	0.27 (12)	Sapora et al. 2010
St. Lazaria I.	0.55	N/A (38)	0.46 (14)	L. Slater Unpubl. Data

[a]Since murres do not build nests, nest sites were defined as sites where eggs were 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 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 any time period at either St. Paul Island or St. George Island. Thick-billed murre populations increased both overall and since 1999 at Buldir Island.

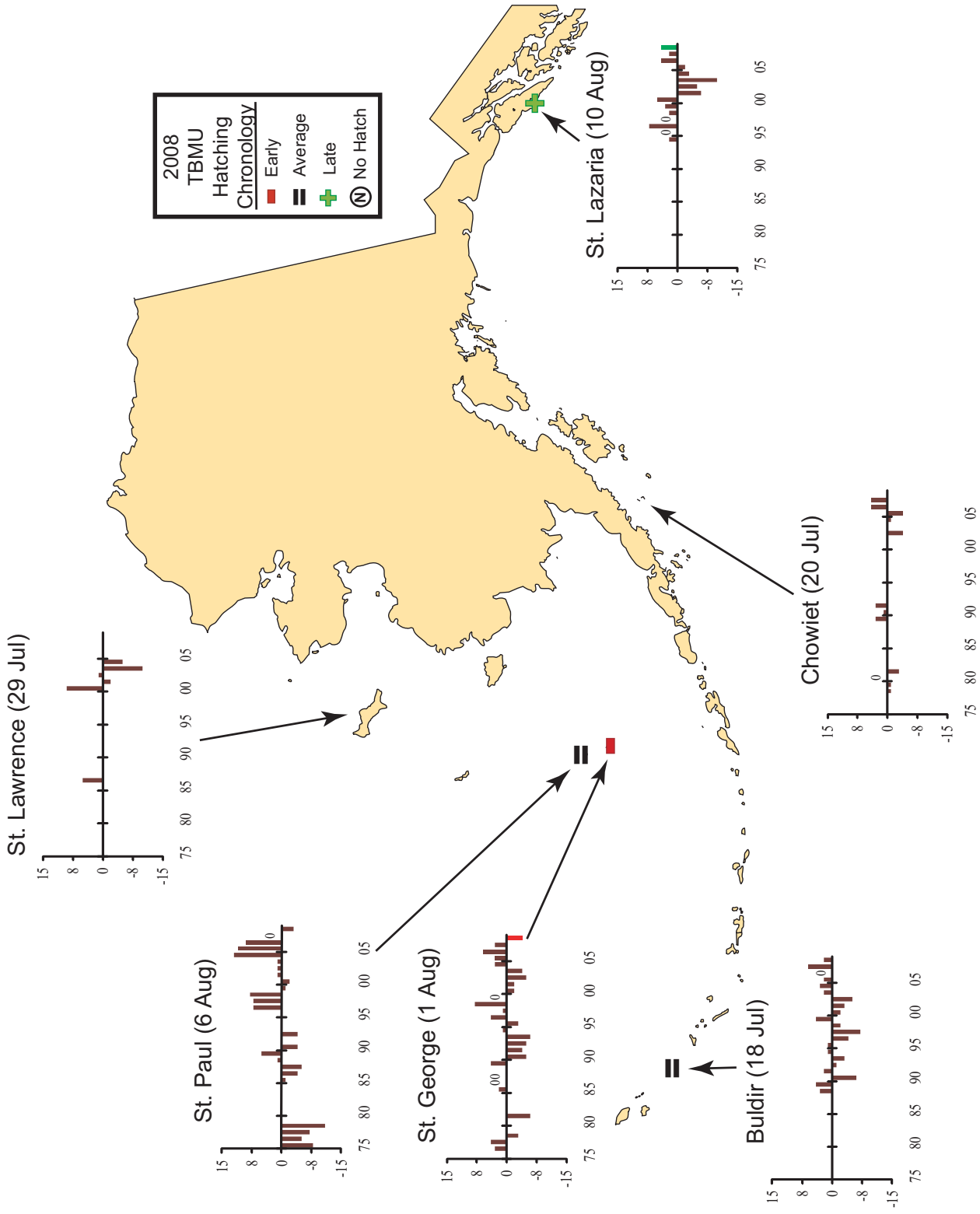

Figure 30. Hatching chronology of thick-billed murres at Alaskan sites monitored in 2008. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

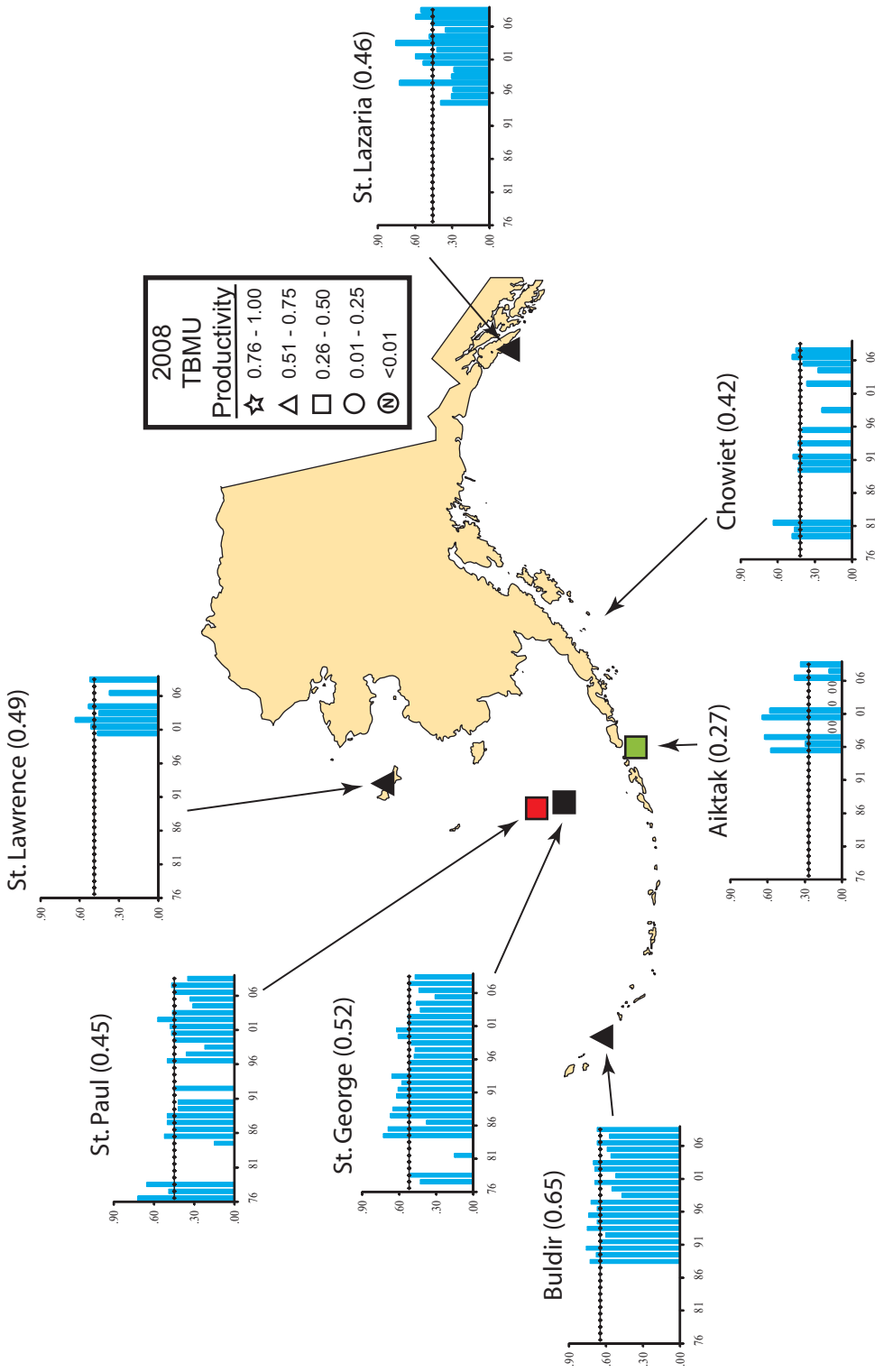

Figure 31. Productivity of thick-billed murres (chicks fledged/nest site) at Alaskan sites monitored in 2008. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current 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 both squid and small fish. Thick-billed murres at Chowiet Island ate sand lance, capelin, and squid.

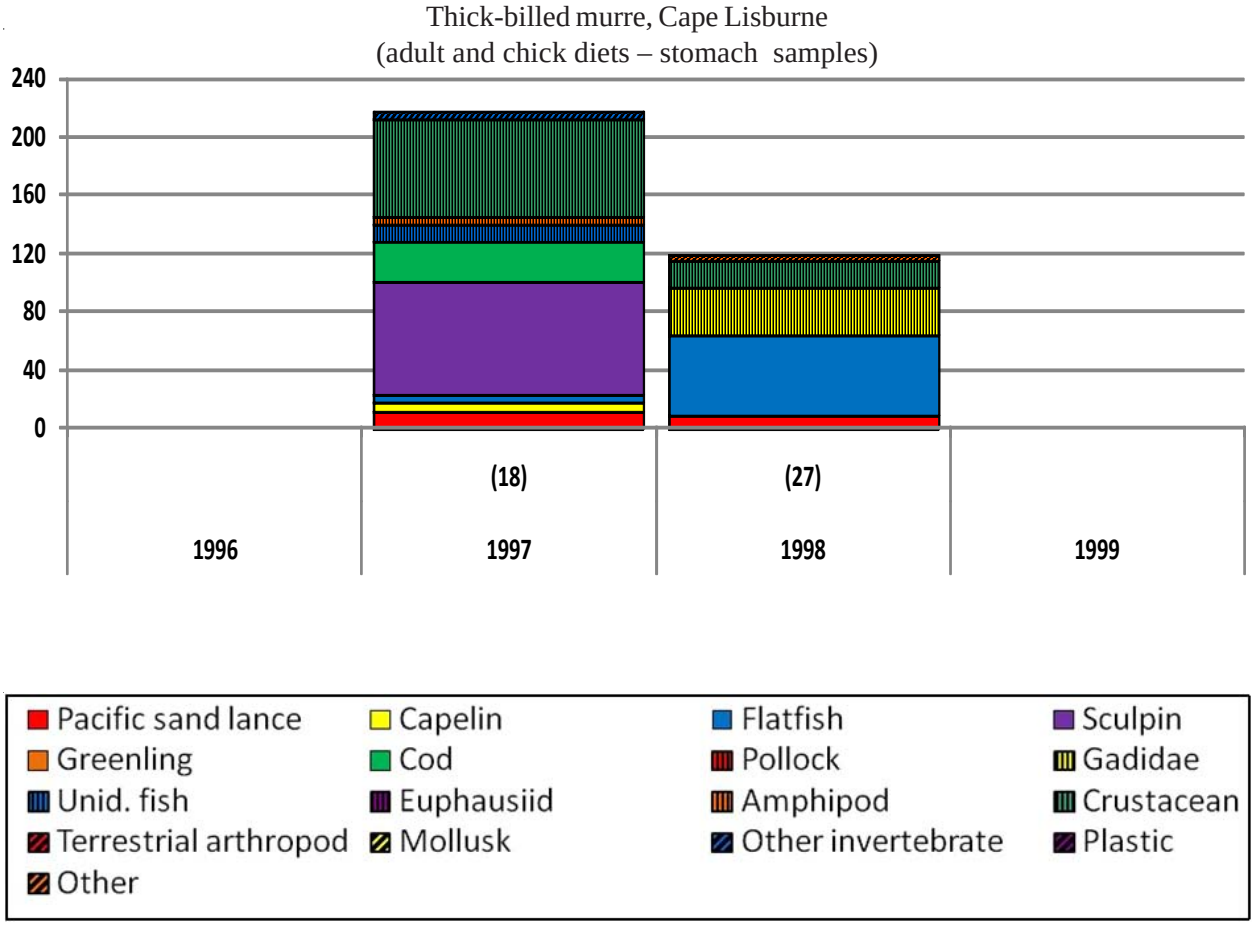

Figure 32. Diets of thick-billed murres at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

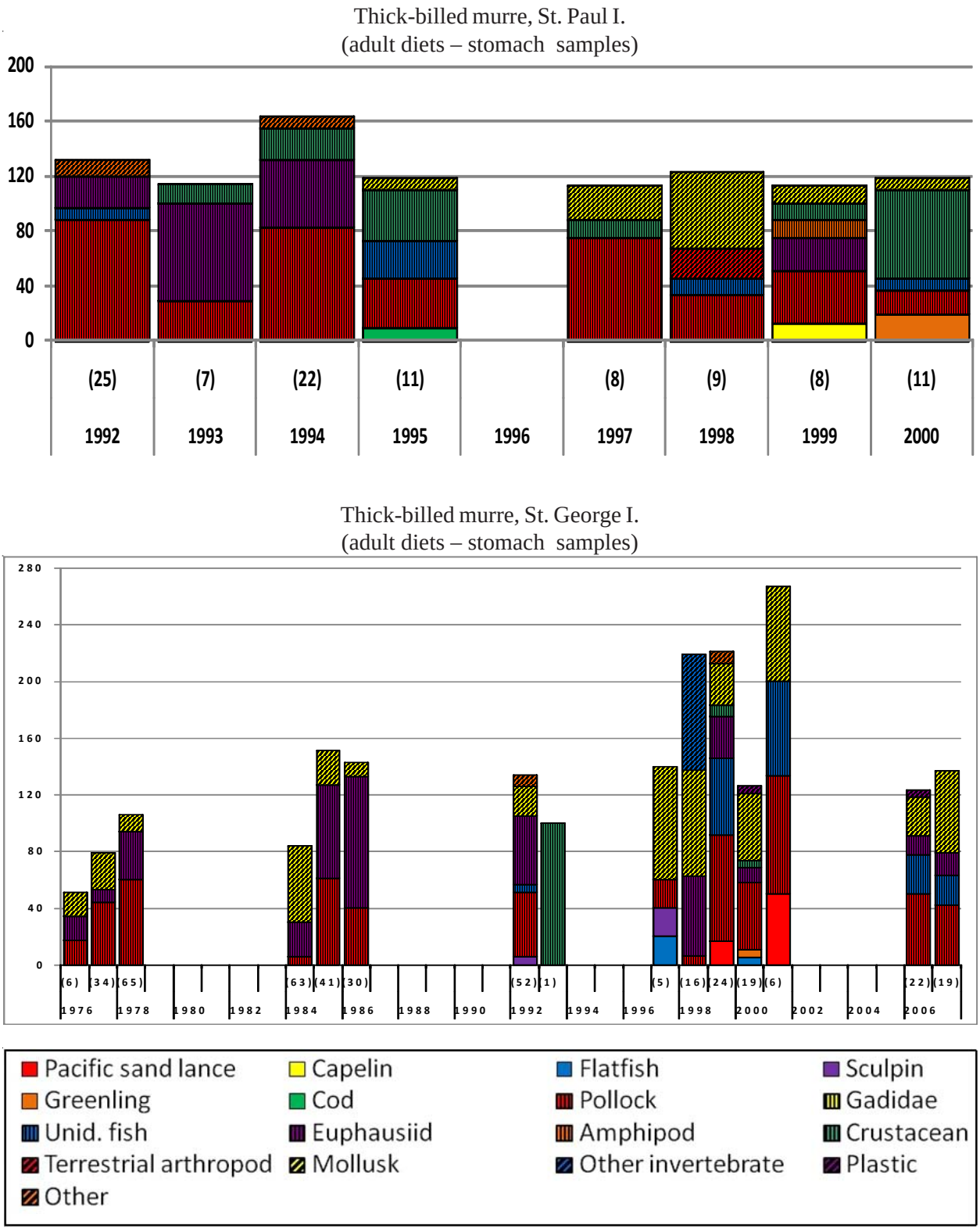

Figure 32 (continued). Diets of thick-billed murres at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

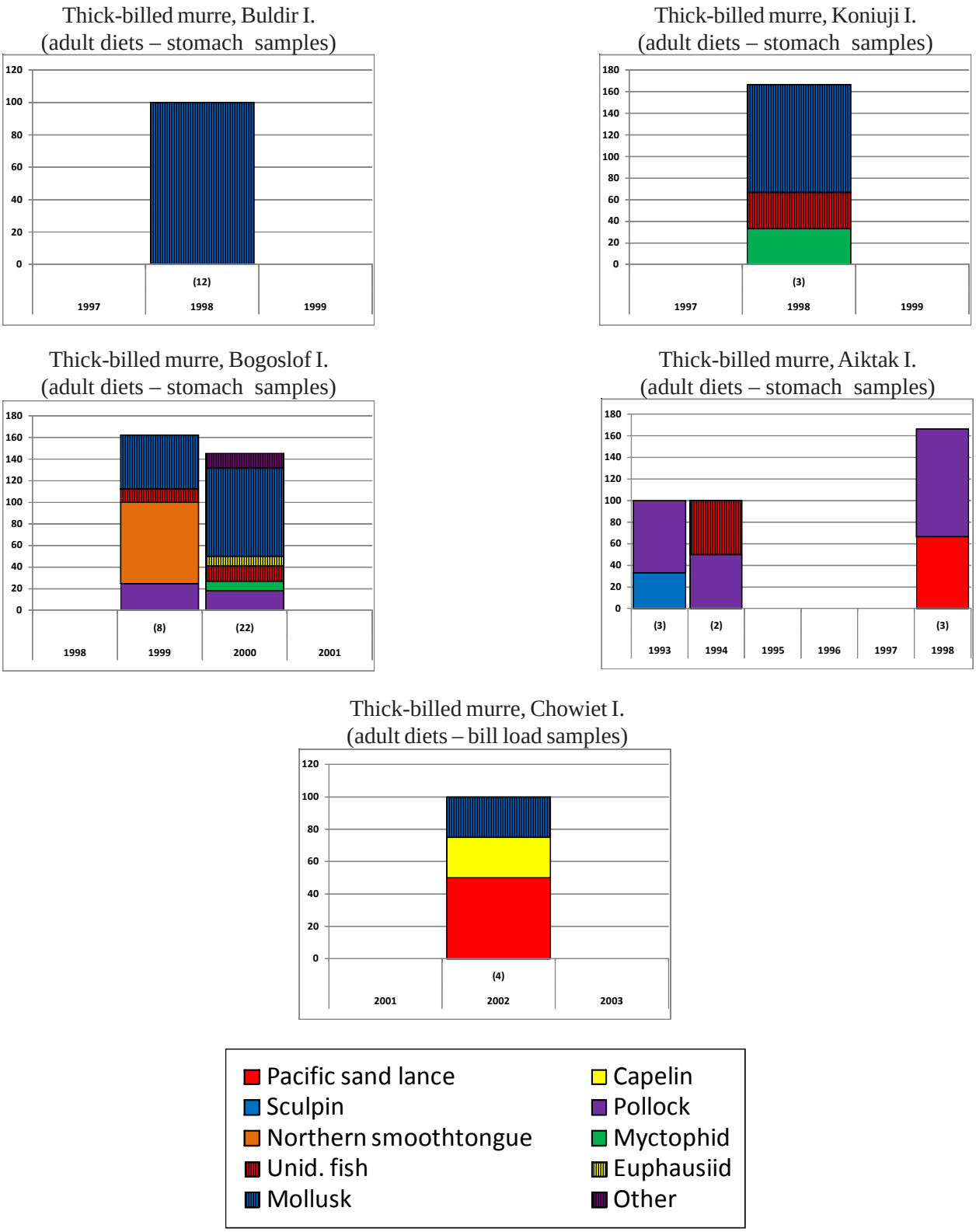

Figure 32 (continued). Diets of thick-billed murres at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

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 since 1999 (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 showed no trend at St. Lazaria Island over all years but declined at that colony in the last decade.

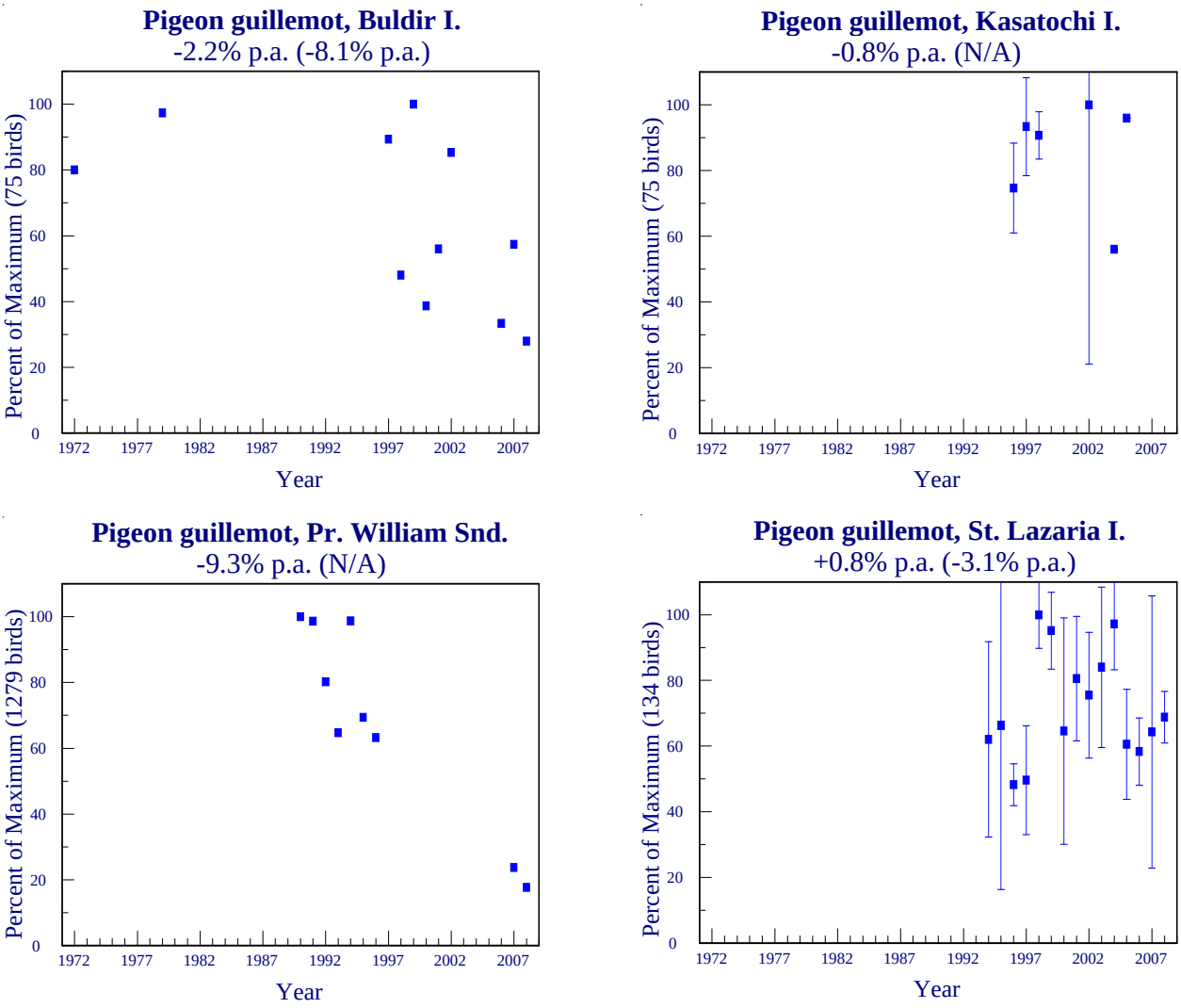

Figure 33. Trends in populations of pigeon guillemots at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (1999-2008, in parentheses). "N/A" indicates that insufficient 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 consisted almost entirely of fish; the predominant taxa were smelt, sand lance, gunnel, and gadid.

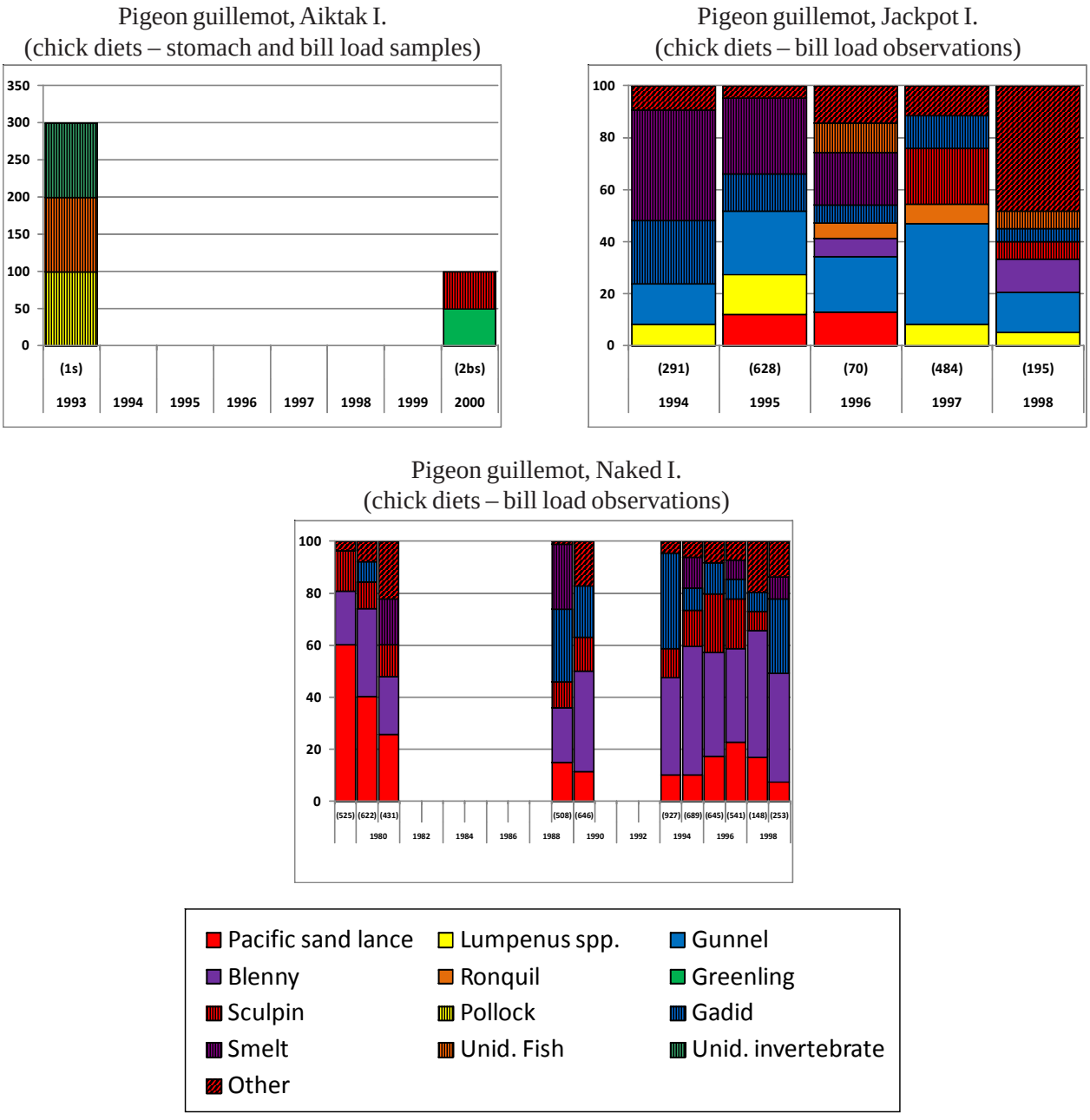

Figure 34. Diets of pigeon guillemots at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar. Because Prince William Sound samples were reported as 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 2008 (Table 19).

Table 19. Hatching chronology of ancient murrelets at Alaskan sites monitored in 2008.

Site	Mean	Long-term Average	Reference
Aiktak I.	4 Jul (37)[a]	4 Jul[b] (11)[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 2008 (Table 20).

Table 20. Reproductive performance of ancient murrelets at Alaskan sites monitored in 2008.

Site	Chicks Fledged/Egg[a]	No. of Plots	Long-term Average	Reference
Aiktak I.	0.88	N/A[b] (84)[c]	0.77 (11)[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 late at Buldir Island, the only site monitored in 2008 (Table 21, Figure 35).

Table 21. Hatching chronology of parakeet auklets at Alaskan sites monitored in 2008.

Site	Mean	Long-term Average	Reference
Buldir I.	7 Jul (24)[a]	4 Jul[b] (16)[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.–Parakeet auklet productivity was average at Buldir Island, the only colony where this species was monitored in 2008 (Table 22, Figure 36).

Table 22. Reproductive performance of parakeet auklets at Alaskan sites monitored in 2008.

Site	Chicks Fledged/ Nest Site[a]	No. of Plots	Long-term Average	Reference
Buldir I.	0.52	N/A[b] (54)[c]	0.51 (16)[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.–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.

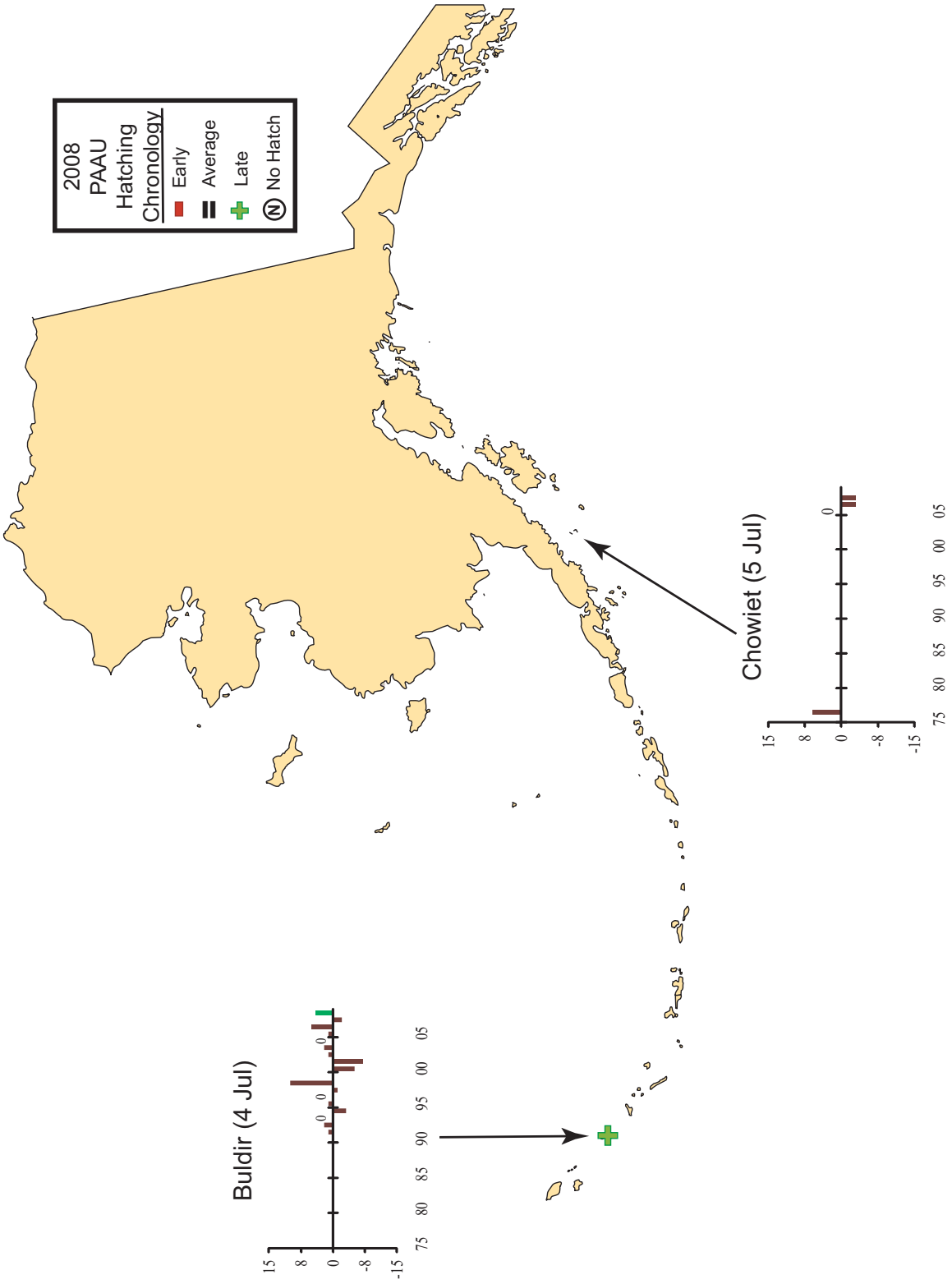

Figure 35. Hatching chronology of parakeet auklets at Alaskan sites monitored in 2008. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

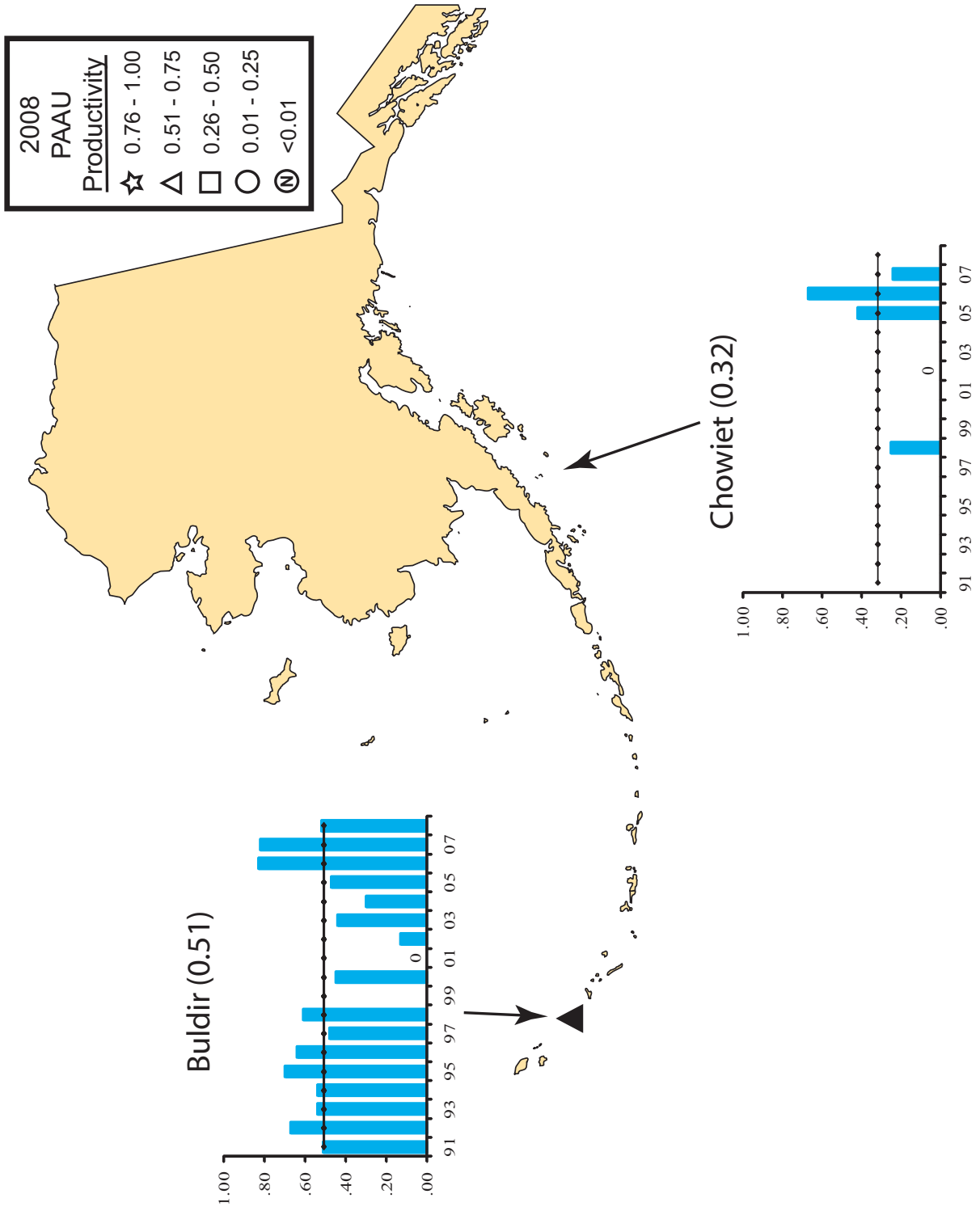

Figure 36. Productivity of parakeet auklets (chicks fledged/nest site) at Alaskan sites monitored in 2008. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

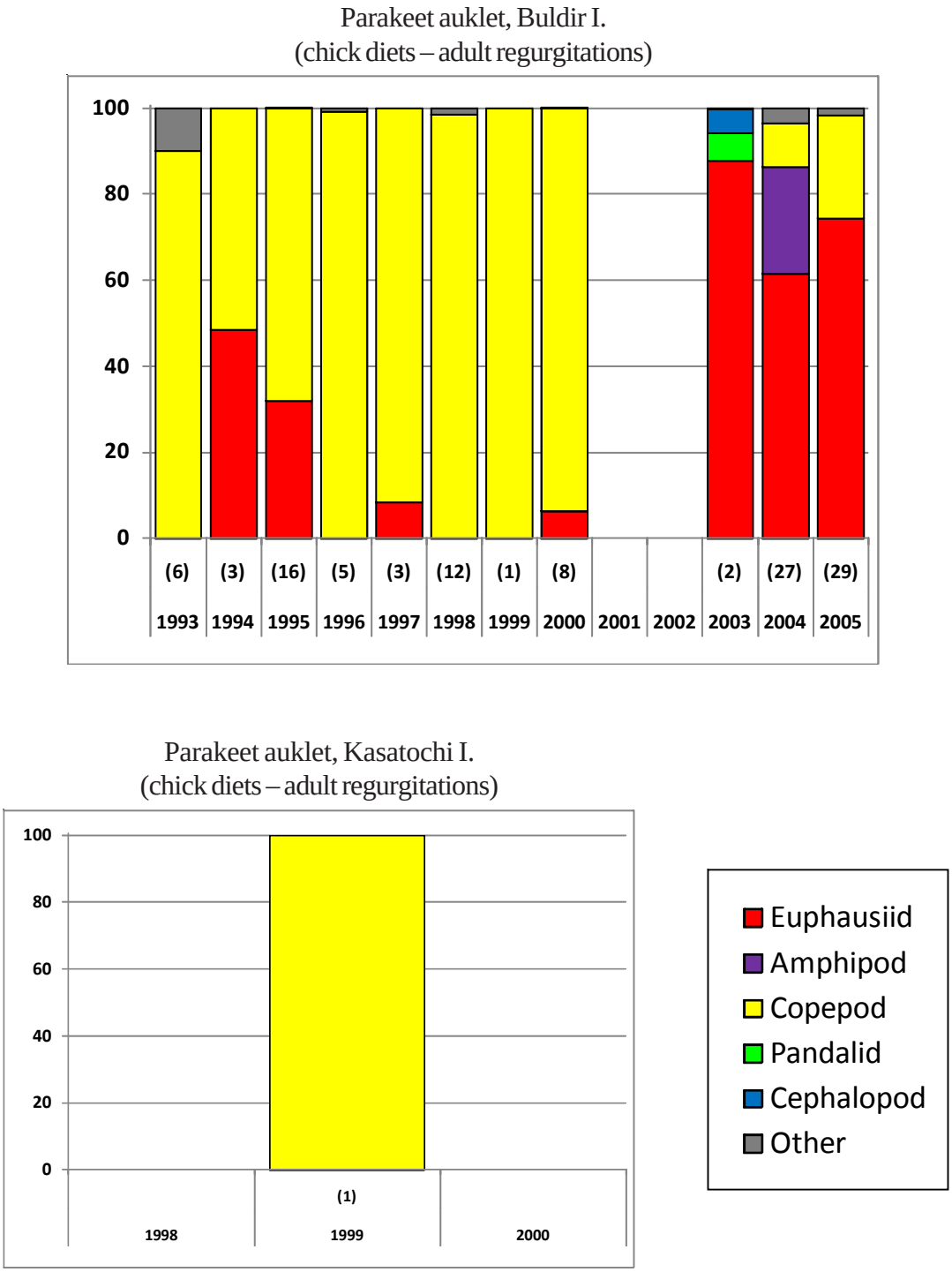

Figure 37. Diets of parakeet auklets at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent biomass of prey type in the diet. Sample sizes are reported below each bar.

Least auklet (*Aethia pusilla*)

Breeding chronology.–The dates of hatching for least auklets were average at all monitored sites in 2008 (Table 23, Figure 38).

Table 23. Hatching chronology of least auklets at Alaskan sites monitored in 2008.

Site	Mean	Long-term Average	Reference
St. George I.	16 Jul (39)[a]	N/A[b]	Shannon et al. 2010
Buldir I.	24 Jun (31)	28 Jun[c] (18)[a]	Freeman et al. 2010
Kiska I.	28 Jun (N/A)	30 Jun[c] (6)	Jones 2010
Kasatochi I.	30 Jun (46)	29 Jun[c] (12)	Buchheit and Ford 2008

[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]Not applicable or not reported.
[c]Mean of annual means.

Productivity.–Least auklet reproductive success was below average at St. Lawrence Island and above average at Buldir and Kiska islands in 2008 (Table 24, Figure 39).

Table 24. Reproductive performance of least auklets at Alaskan sites monitored in 2008.

Site	Chicks Fledged/ Nest Site[a]	No. of Plots	Long-term Average	Reference
St. Lawrence I.	0.28	N/A[b] (N/A)[c]	0.63 (7)[c]	D. Irons Unpubl. Data
St. George I.	0.64	N/A (59)	N/A	Shannon et al. 2010
Buldir I.	0.70	N/A (67)	0.55 (18)	Freeman et al. 2010
Kiska I.	0.64	N/A (157)	0.40 (6)	Jones 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.–We found no population trends for least auklets at St. George Island during all years or for the last dacade (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.

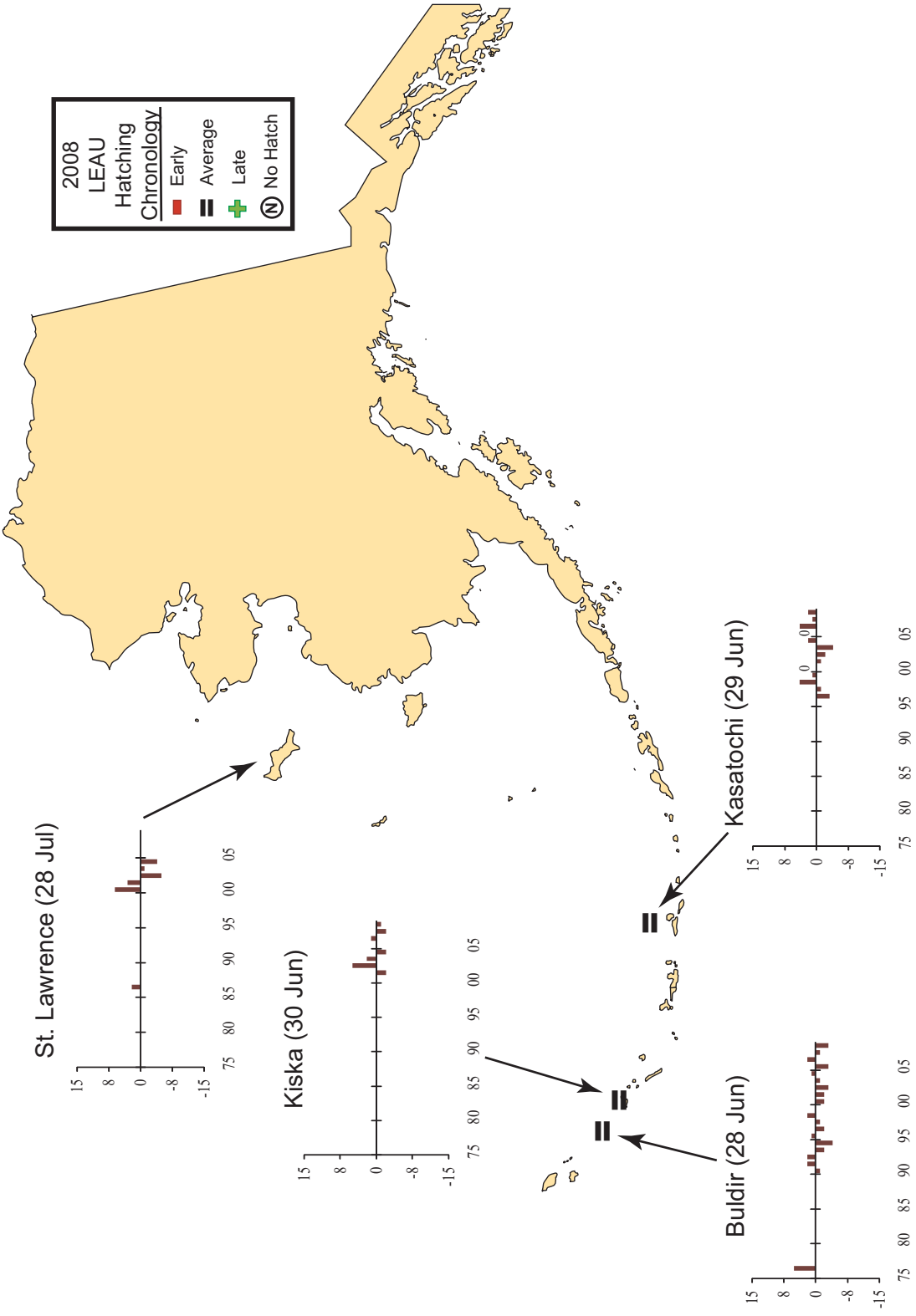

Figure 38. Hatching chronology of least auklets at Alaskan sites monitored in 2008. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

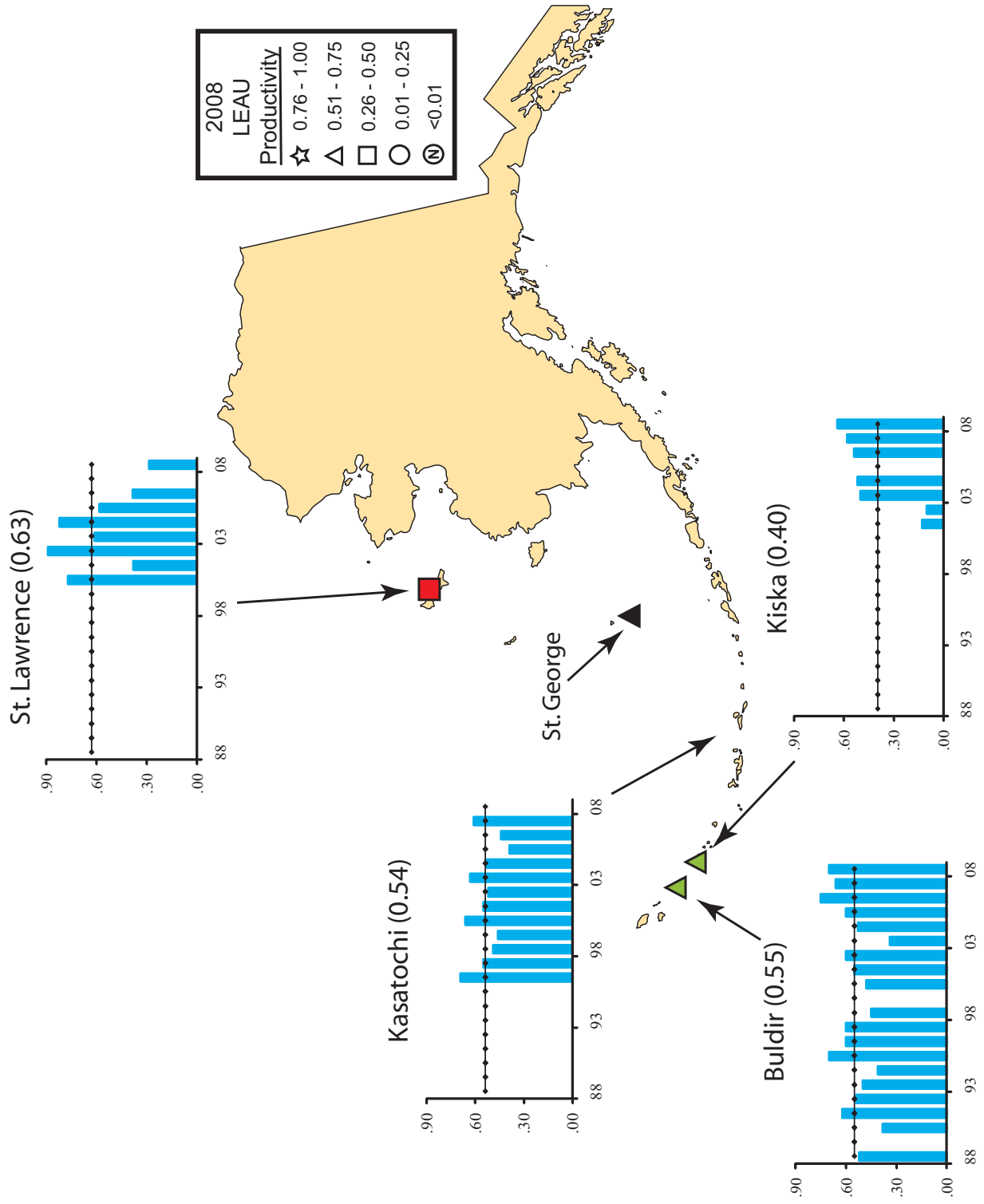

Figure 39. Productivity of least auklets (chicks fledged/nest site) at Alaskan sites monitored in 2008. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

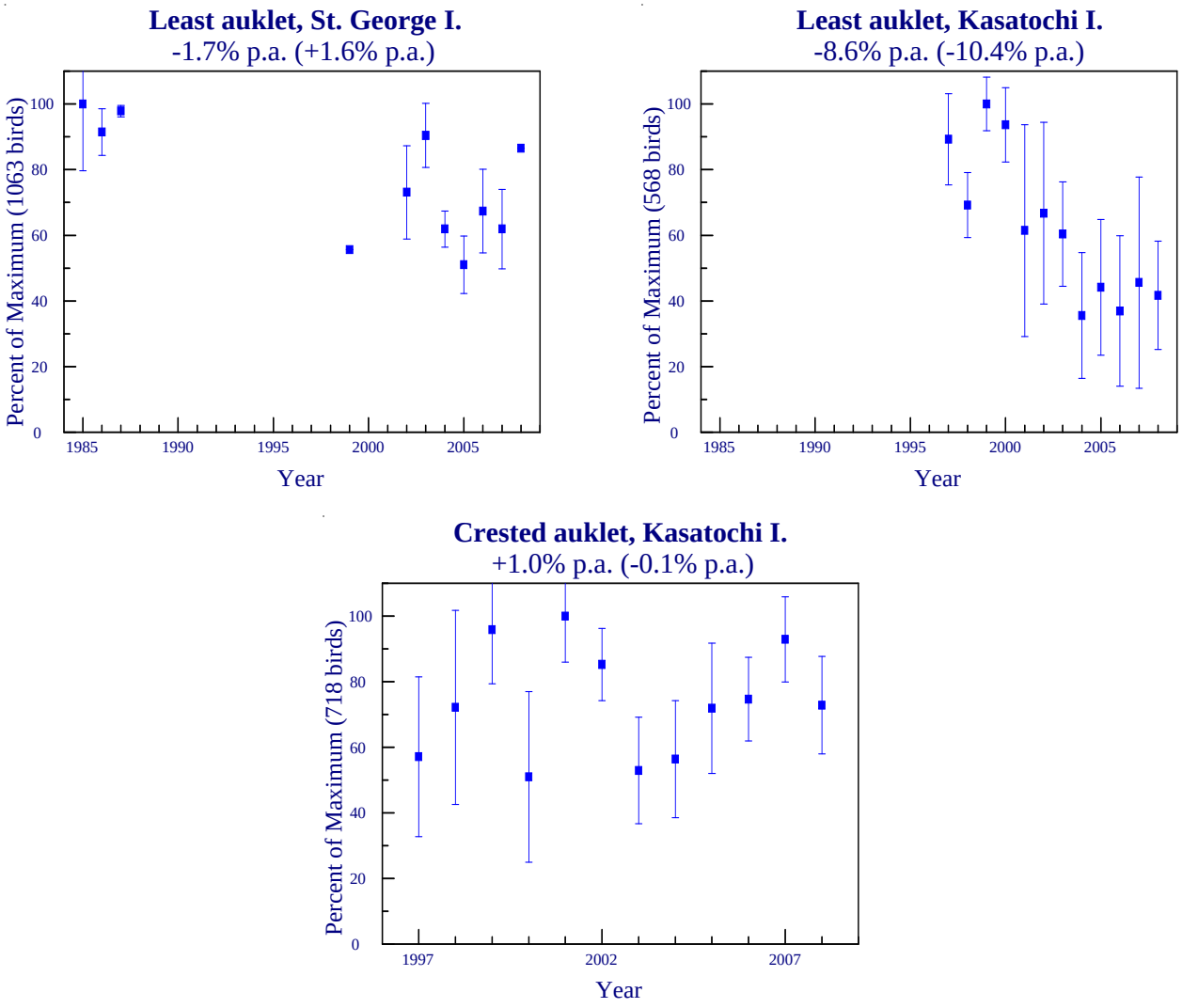

Figure 40. Trends in populations of least (top) and crested (bottom) auklets at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (1999-2008, in parentheses).

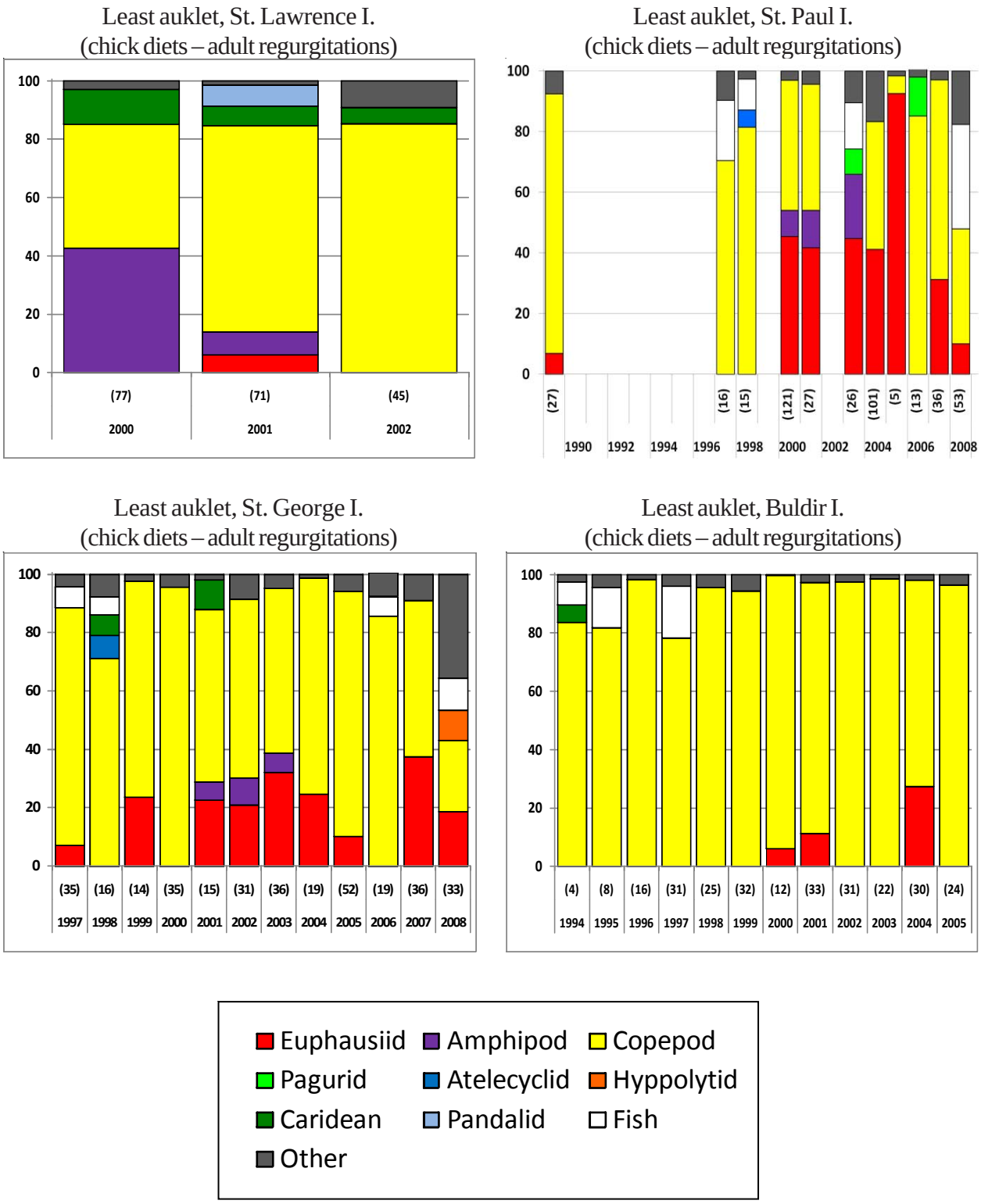

Figure 41. Diets of least auklets at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent biomass of prey type in the diet. Sample sizes are reported below each bar.

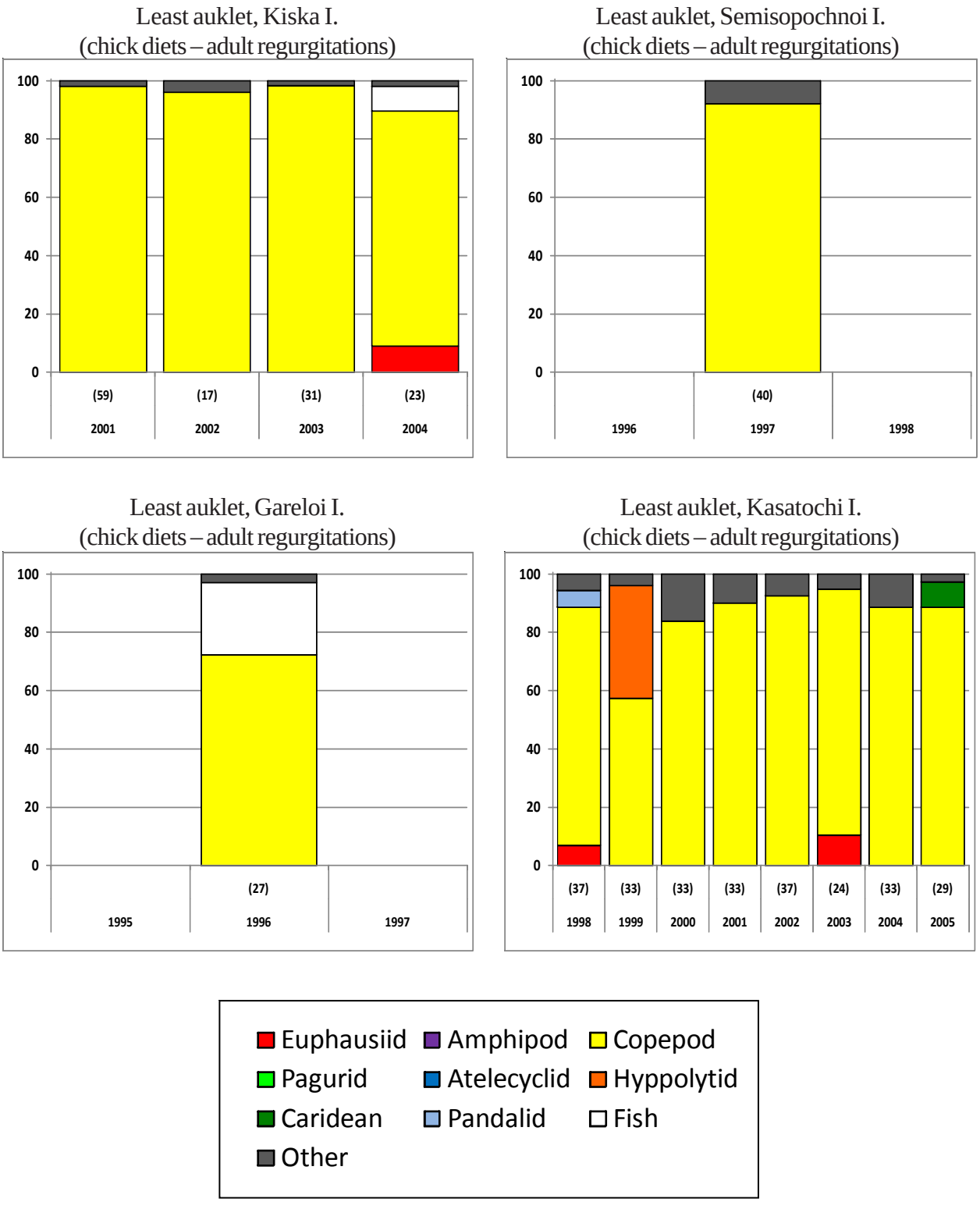

Figure 41 (continued). Diets of least auklets at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent biomass of prey type in the diet. Sample sizes are reported below each bar.

Whiskered auklet (*Aethia pygmaea*)

Breeding chronology.–The mean hatching date for whiskered auklets was average at Buldir Island in 2008 (Table 25).

Table 25. Hatching chronology of whiskered auklets at Alaskan sites monitored in 2008.

Site	Mean	Long-term Average	Reference
Buldir I.	21 Jun (40)	23 Jun[b] (18)[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 and comparatively low at Kasatochi Island in 2008 (Table 26).

Table 26. Reproductive performance of whiskered auklets at Alaskan sites monitored in 2008.

Site	Chicks Fledged/ Nest Site[a]	No. of Plots	Long-term Average	Reference
Buldir I.	0.84	N/A[b] (68)[c]	0.60 (17)[c]	Freeman et al. 2010
Kasatochi I.	0.25	N/A (4)	N/A	Buchheit and Ford 2008

[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).

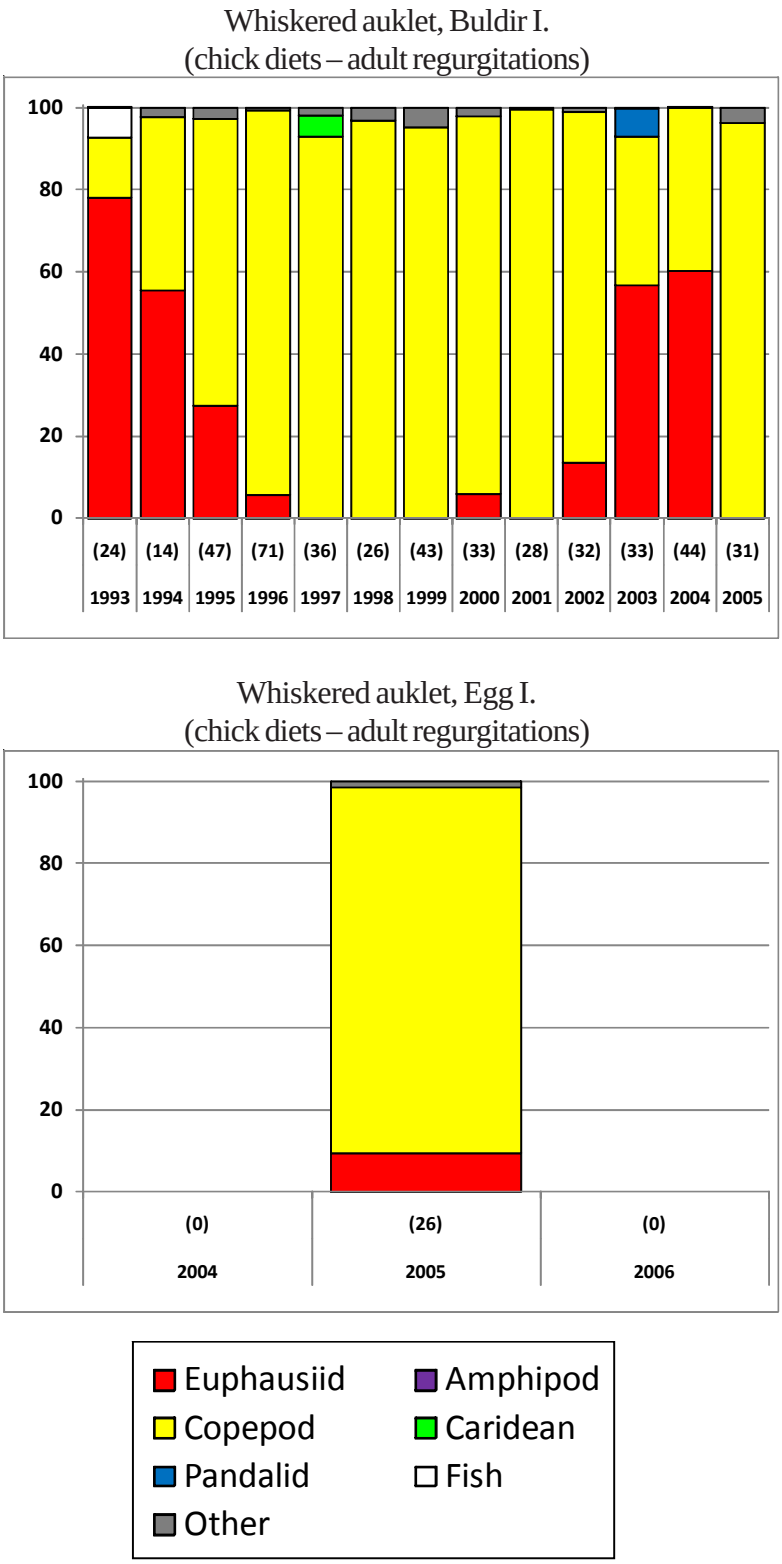

Figure 42. Diets of whiskered auklets at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent biomass of prey type in the diet. Sample sizes are reported below each bar.

Crested auklet (*Aethia cristatella*)

Breeding chronology.–The mean date of hatching for crested auklets was average at all monitored colonies in 2008. (Table 27, Figure 43).

Table 27. Hatching chronology of crested auklets at Alaskan sites monitored in 2008.

Site	Median	Mean	Long-term Average	Reference
Buldir I.	—	26 Jun (36)[a]	29 Jun[b] (18)[a]	Freeman et al. 2010
Kiska I.	—	29 June (N/A[c])	3 Jul[b] (4)	Jones 2010
Kasatochi I.	2 Jul (51)	1 Jul (51)	1 Jul[b] (12)	Buchheit and Ford 2008

[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.–Crested auklets exhibited below average success at St. Lawrence Island, average productivity at Kiska Island and above average success at Buldir Island 2008 (Table 28, Figure 44).

Table 28. Reproductive performance of crested auklets at Alaskan sites monitored in 2008.

Site	Chicks Fledged/ Nest Site[a]	No. of Plots	Long-term Average	Reference
St. Lawrence I.	0.43	N/A[b] (N/A)[c]	0.67 (7)[c]	D. Irons Unpubl. Data
Buldir I.	0.83	N/A (75)	0.63 (18)	Freeman et al. 2010
Kiska I.	0.59	N/A (29)	0.56 (6)	Jones 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.–We found no population trends for crested auklets at Kasatochi Island either for all years or since 1999 (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.

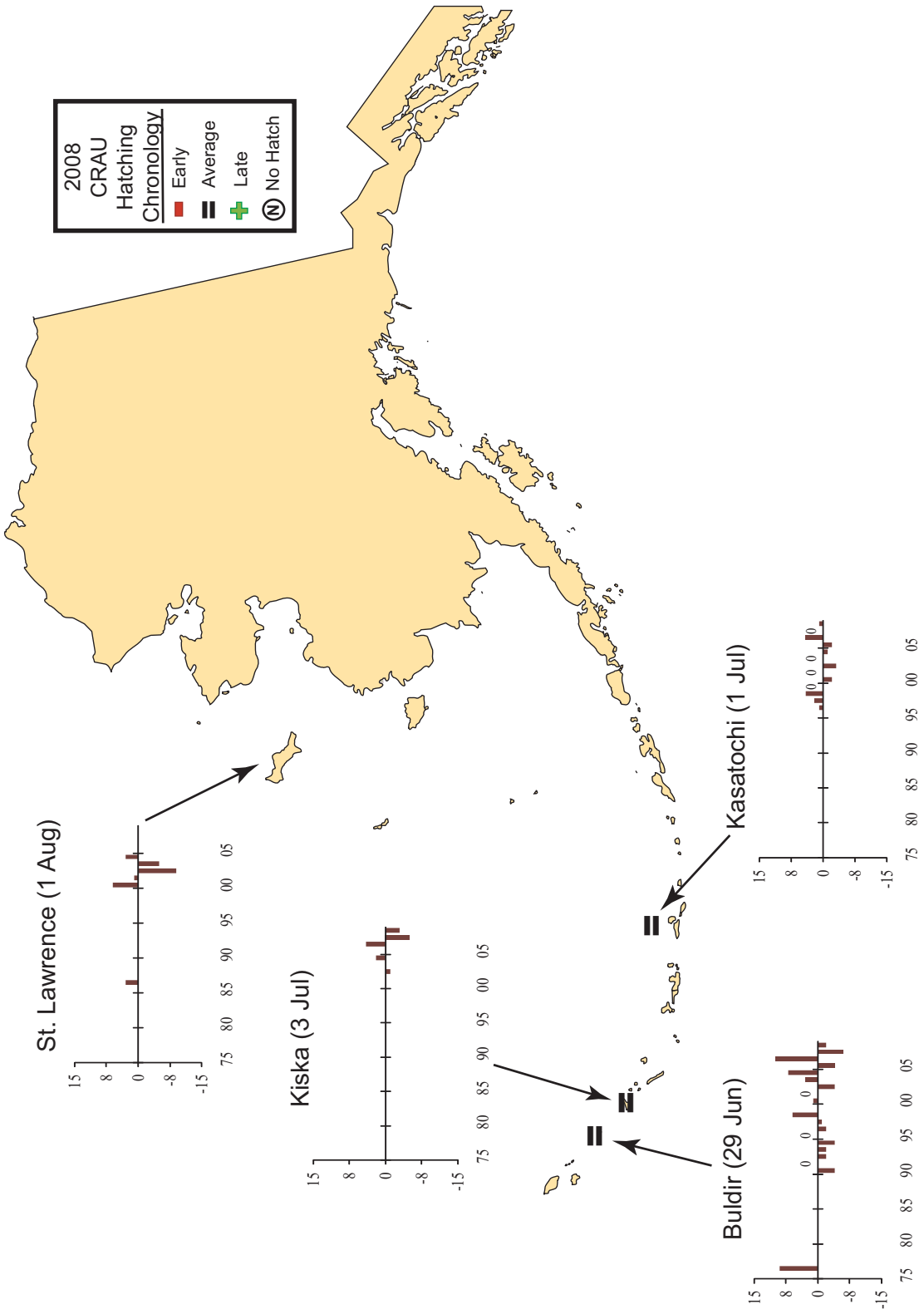

Figure 43. Hatching chronology of crested auklets at Alaskan sites monitored in 2008. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

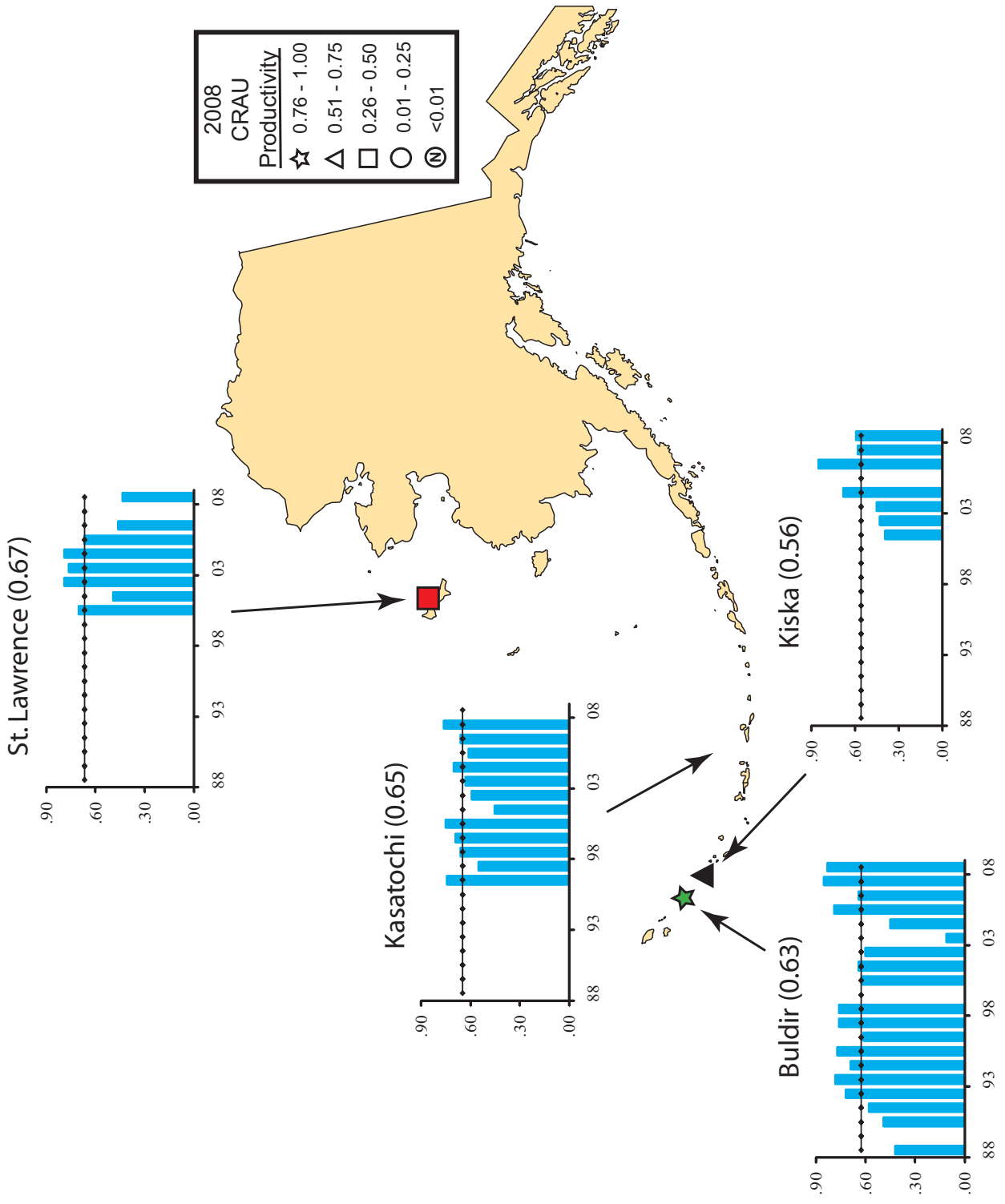

Figure 44. Productivity of crested auklets (chicks fledged/nest site) at Alaskan sites monitored in 2008. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

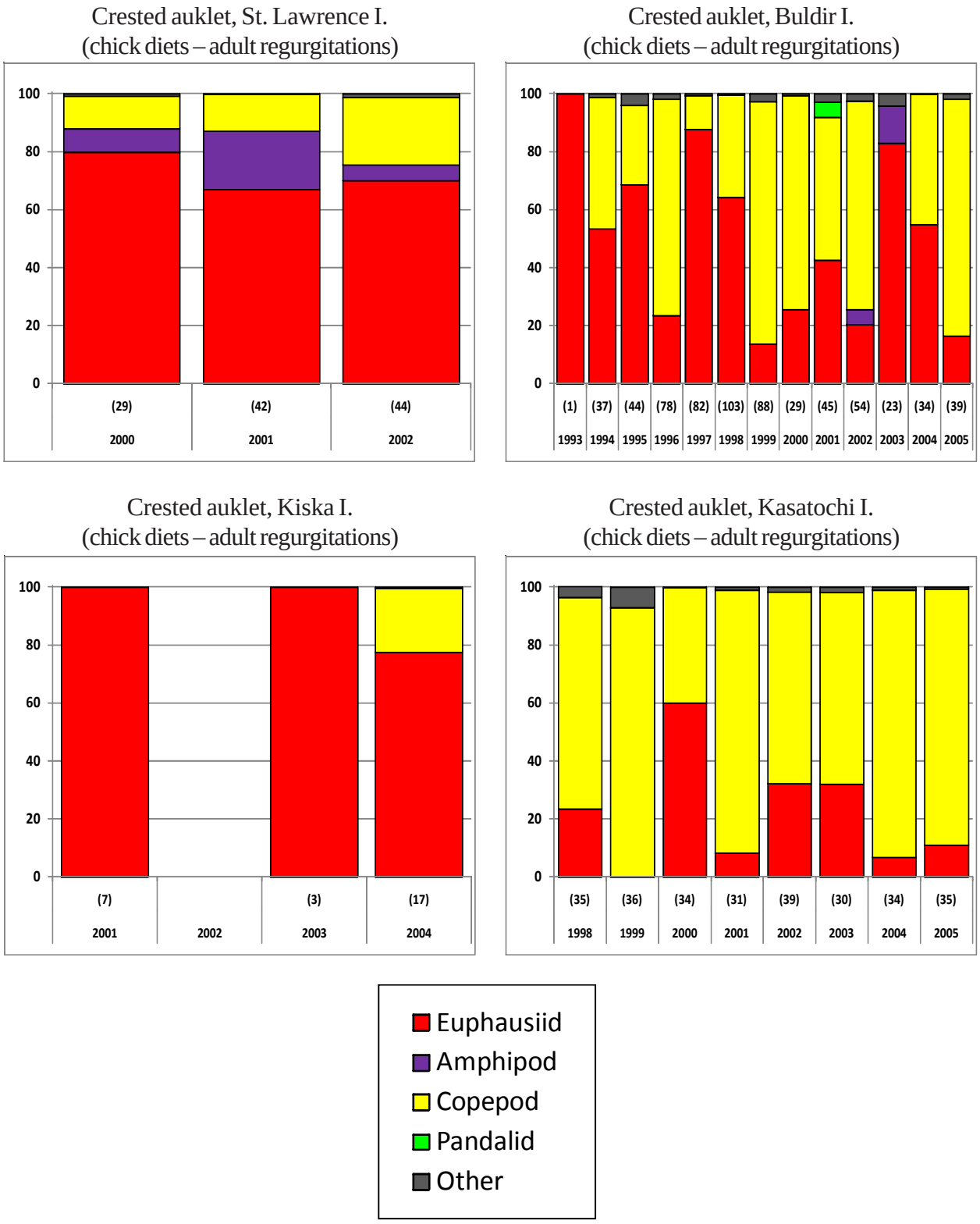

Figure 45. Diets of crested auklets at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent biomass of prey type in the diet. Sample sizes are reported below each bar.

Rhinoceros auklet (*Cerorhinca monocerata*)

Breeding chronology.–No data in 2008.

Productivity.–No data in 2008.

Populations.–We found positive trends in populations of rhinoceros auklets at St. Lazaria Island for all years as well as in the last decade (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.

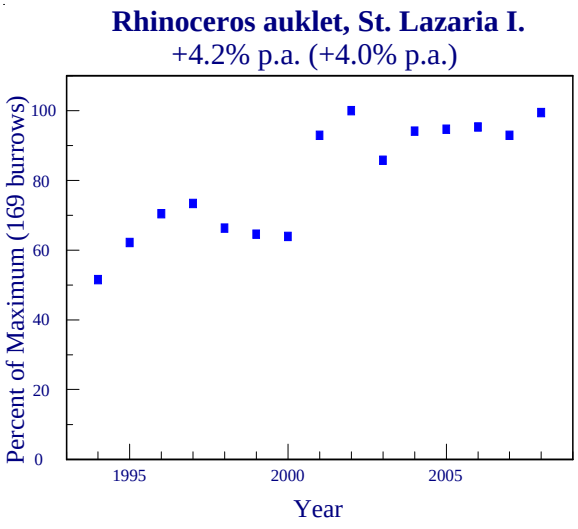

Figure 46. Trends in populations of rhinoceros auklets at Alaskan sites. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (1999-2008, in parentheses).

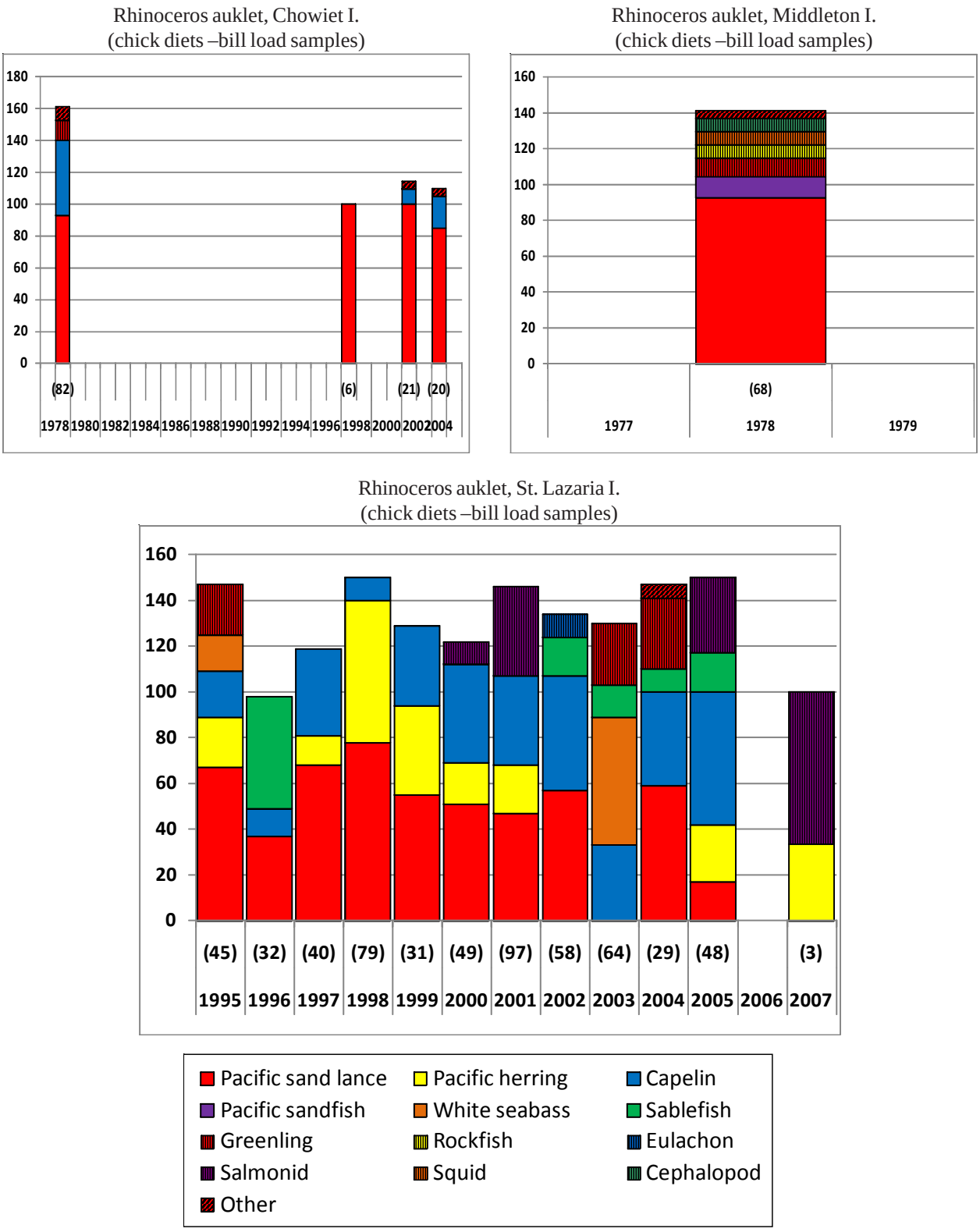

Figure 47. Diets of rhinoceros auklets at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Horned puffin (*Fratercula corniculata*)

Breeding chronology.–Horned puffin breeding chronology was late at Buldir Island and average at Aiktak Island in 2008 (Table 29, Figure 48).

Table 29. Hatching chronology of horned puffins at Alaskan sites monitored in 2008.

Site	Mean	Long-term Average	Reference
Buldir I.	27 Jul (26)[a]	24 Jul[b] (20)[a]	Freeman et al. 2010
Aiktak I.	3 Aug (7)	1 Aug[b] (6)	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.–Horned puffins exhibited above average productivity at Aiktak Island, and average success at Buldir Island in 2008 (Table 30, Figure 49).

Table 30. Reproductive performance of horned puffins at Alaskan sites monitored in 2008.

Site	Chicks Fledged/Egg	No. of Plots	Long-term Average	Reference
Buldir I.	0.37	N/A[a] (46)[b]	0.44 (20)[b]	Freeman et al. 2010
Aiktak I.	0.82	N/A (6)	0.42 (8)	Sapora 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.

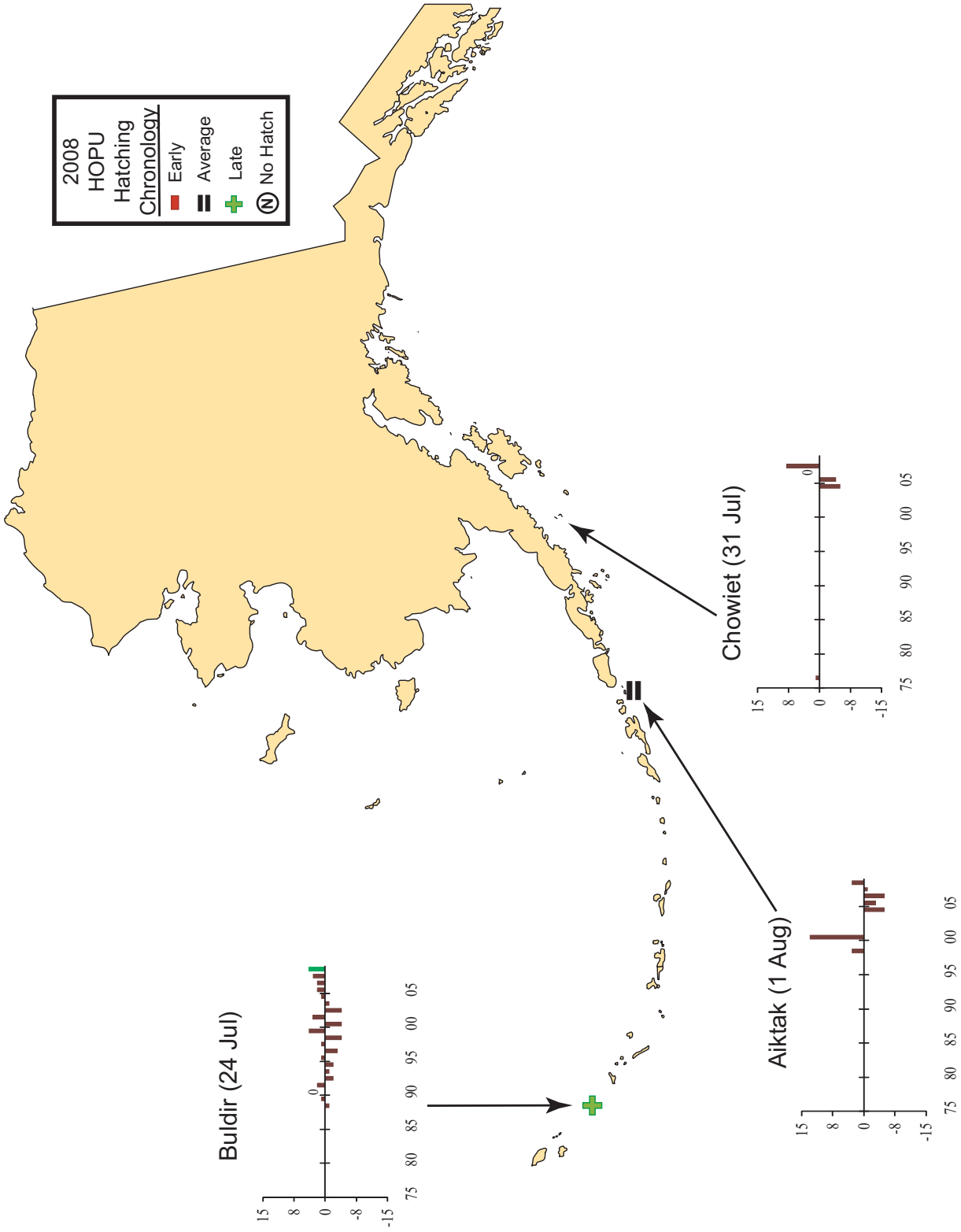

Figure 48. Hatching chronology of horned puffins at Alaskan sites monitored in 2008. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

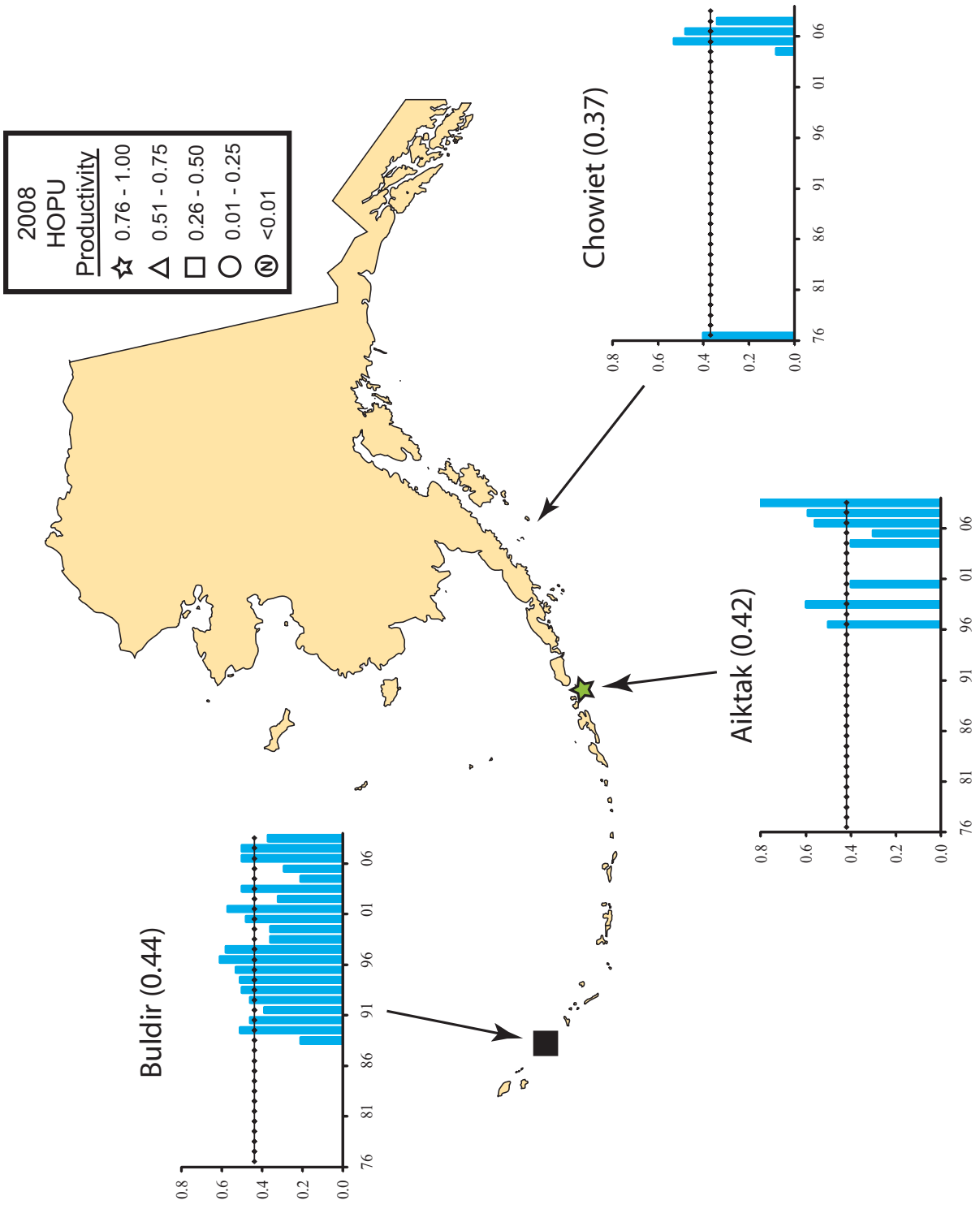

Figure 49. Productivity of horned puffins (chicks fledged/egg) at Alaskan sites monitored in 2008. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

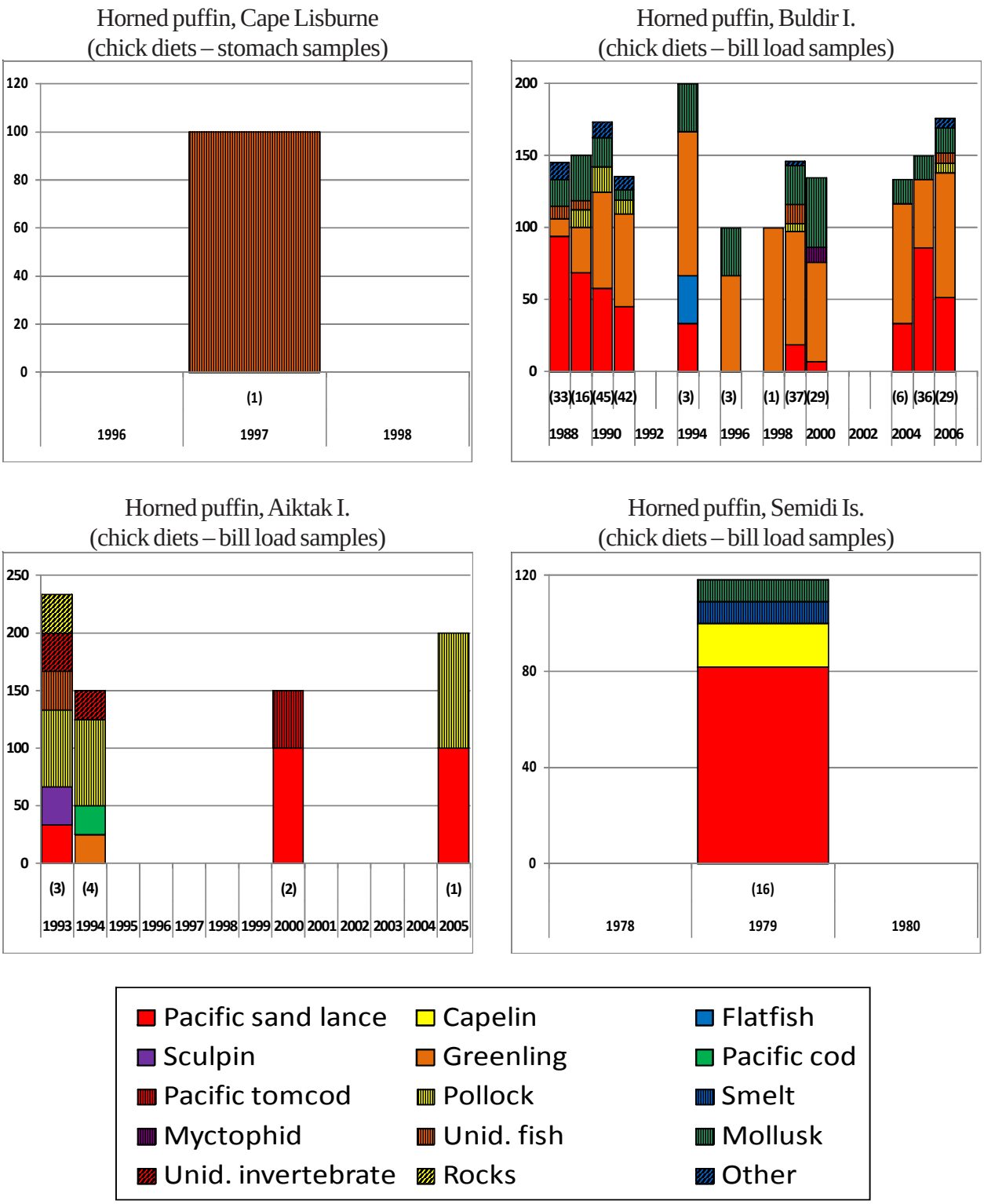

Figure 50. Diets of horned puffins at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Tufted puffin (*Fratercula cirrhata*)

Breeding chronology.–Hatch dates for tufted puffins were early at Buldir and Aiktak islands in 2008 (Table 31, Figure 51).

Table 31. Hatching chronology of tufted puffins at Alaskan sites monitored in 2008.

Site	Mean	Long-term Average	Reference
Buldir I.	9 Jul (11)[a]	15 Jul[b] (18)[a]	Freeman et al. 2010
Aiktak I.	24 Jul (55)	4 Aug[b] (11)	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.–In 2008, tufted puffin productivity was above average at Buldir and Aiktak islands (Table 32, Figure 52).

Table 32. Reproductive performance of tufted puffins at Alaskan sites monitored in 2008.

Site	Chicks Fledged[a]/Egg	No. of Plots	Long-term Average	Reference
Buldir I.	0.63	N/A[b] (26)[c]	0.43 (20)[c]	Freeman et al. 2010
Aiktak I.	0.77	N/A (94)	0.47 (12)	Sapora 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.–We found a positive population trend for tufted puffins in all years at Bogoslof Island but numbers have been stable there since 1999 (Figure 53). No trends were evident for either time period at Aiktak Island. Puffin burrow numbers declined overall, and during the last decade as well, at East Amatuli Island. A negative trend in 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.

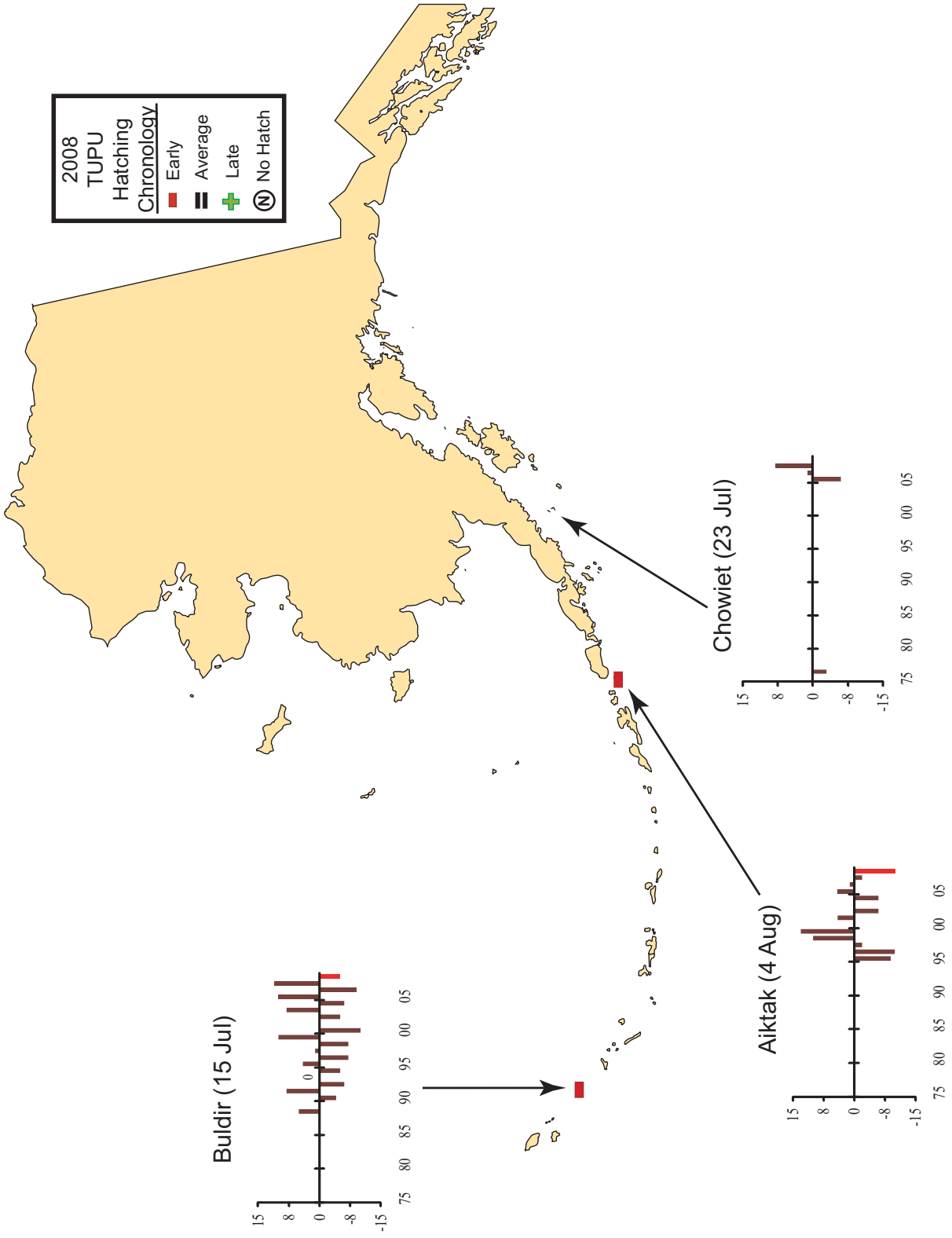

Figure 51. Hatching chronology of tufted puffins at Alaskan sites monitored in 2008. Graphs indicate the departure in days (if any) from the site mean (in parentheses; current year not included).

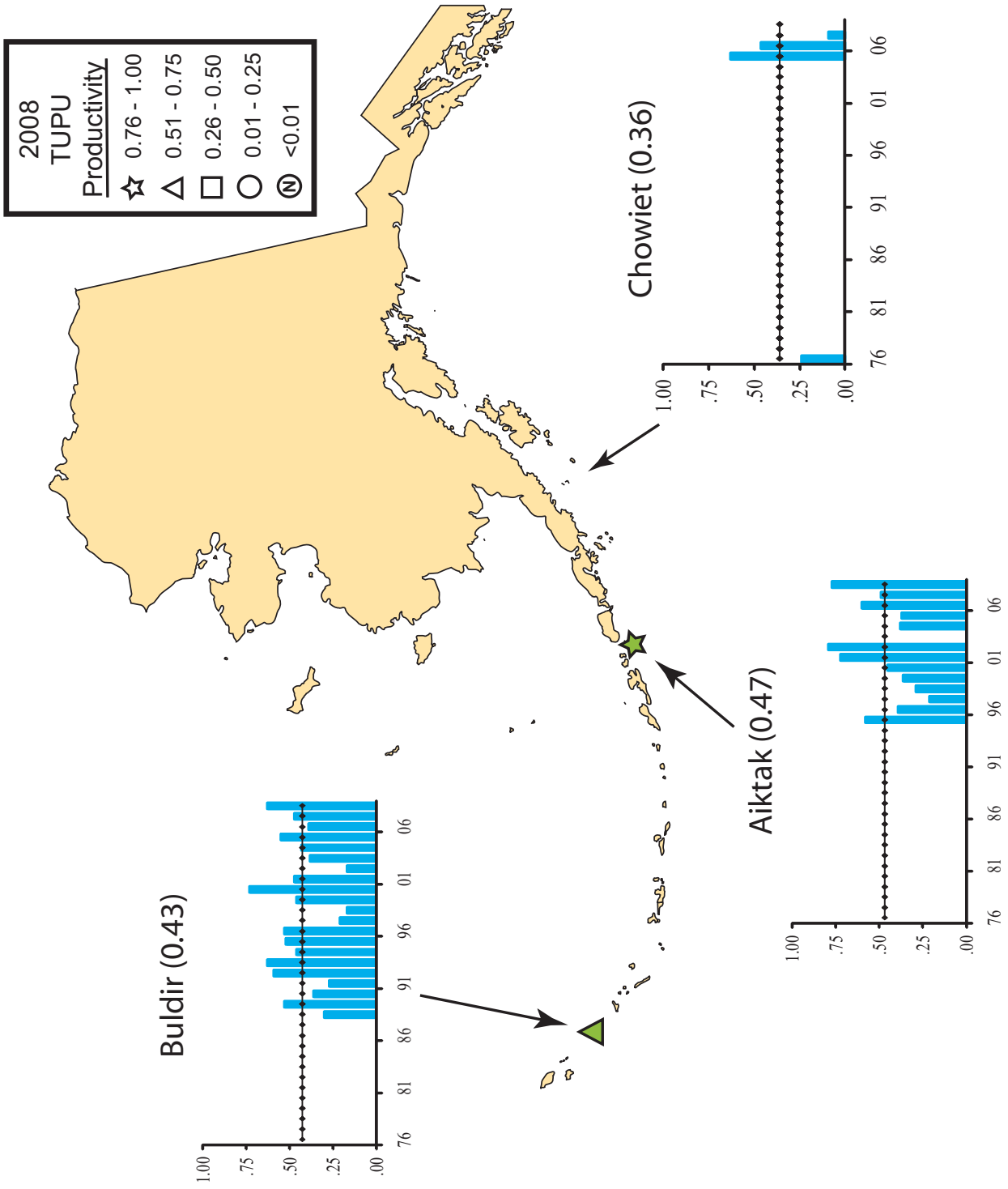

Figure 52. Productivity of tufted puffins (chicks fledged/egg) at Alaskan sites monitored in 2008. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is >20% above site mean).

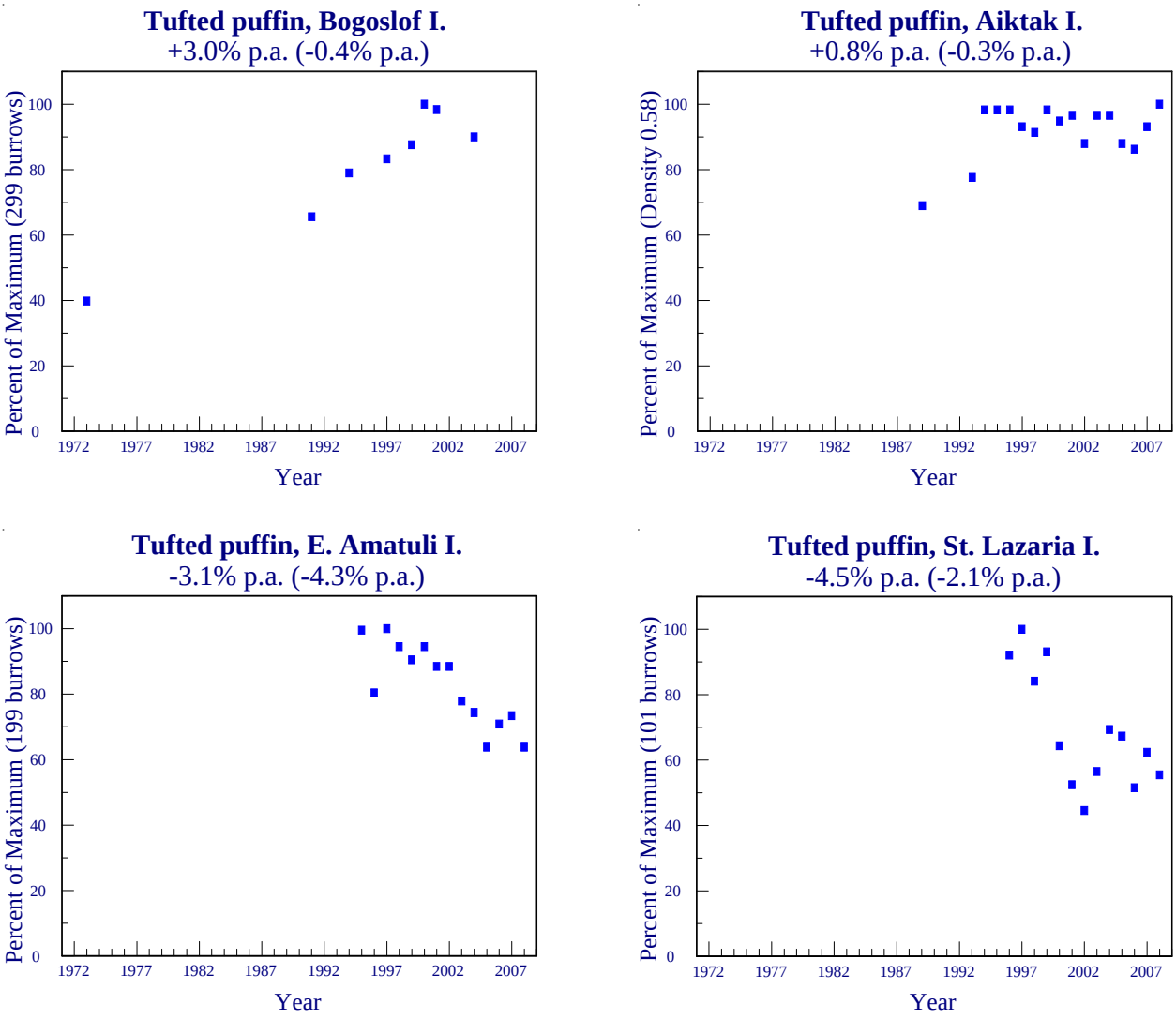

Figure 53. Trends in populations of tufted puffins at Alaskan sites. Percent per annum (p.a.) changes are indicated for all years and for just the last decade (1999-2008, in parentheses).

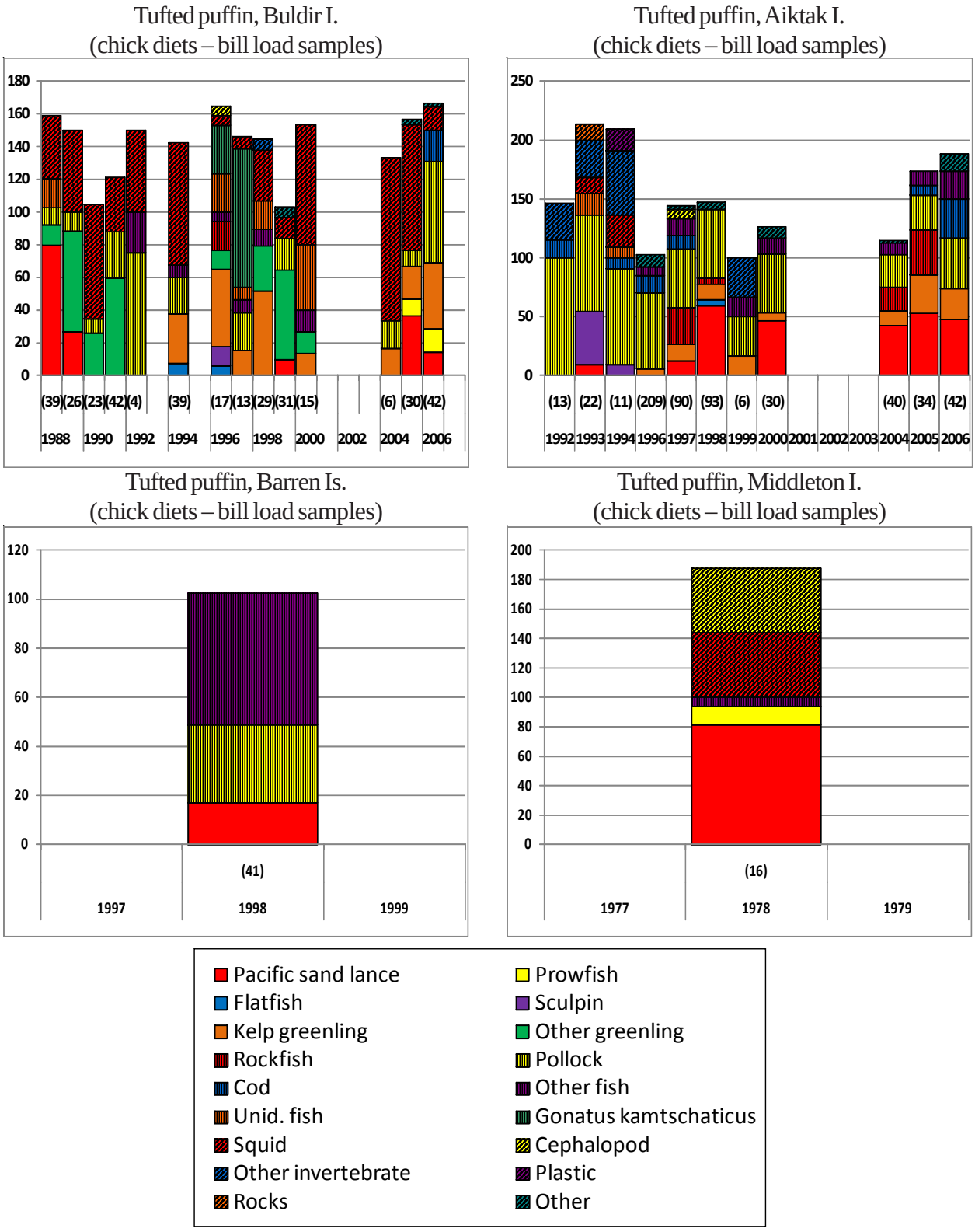

Figure 54. Diets of tufted puffins at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Summary

Species differences

Surface plankton-feeders.–In 2008, timing of hatching was early or average for fork-tailed (FTSP) and Leach's storm-petrels (LESP) at Aiktak and St. Lazaria islands (Table 33). Storm-petrels had average reproductive success at all monitored sites in 2008, except that fork-tailed storm-petrel productivity was lower than average at Kasatochi Island and high at St. Lazaria Island (Table 34). Storm-petrel (STPE) burrow counts (species combined) have remained stable both in the long term and since 1999 (Table 35).

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, we found that fulmar populations were stable at the Pribilof Islands and increasing at Chowiet Island (Table 35).

Glaucous-winged gulls (GWGU) are treated here, although they are opportunistic feeders taking other birds as well as fish for prey. In 2008, gull mean hatch date was average at Aiktak and St. Lazaria islands (Table 33). Gulls had below average success at Aiktak Island and above average success at Buldir and St. Lazaria islands in 2008 (Table 34). Glaucous-winged gull populations showed a decline at Buldir Island, no trends at three colonies, and increases at Middleton and St. Lazaria islands when all years were included (Table 35). During the last decade, gull populations continued to declined at Buldir Island, became stable at Middleton Island and increased at three sites.

Black-legged kittiwake (BLKI) hatch dates were earlier than normal at all monitored locations in 2008 (Table 33). In 2008, black-legged kittiwake productivity was below average at five of the nine monitored sites, average at one site and above average at three colonies (Table 34). For all years, black-legged kittiwake populations exhibited declines at three colonies, no trends at seven sites and positive trends at two locations (Table 35). Since 1999, populations declined at three colonies, exhibited no trend at three sites and increased at 5 locations.

Red-legged kittiwake (RLKI) hatching chronology was early at St. Paul, St. George and Buldir islands in 2008 (Table 33). Reproductive success was above average at St. Paul, St. George and Buldir islands in 2008 (Table 34). 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 35). In the last decade, the decline continued at St. Paul Island, populations remained stable at Buldir Island and numbers increased at St. George Island.

Diving fish-feeders (nearshore).–Timing of hatching was late for red-faced cormorants (RFCO) at St. Paul Island in 2008 (Table 33). Red-faced cormorants had below average productivity at St. George Island, average success at Aiktak and Buldir islands, and high productivity at St. Paul Island in 2008 (Table 34). Pelagic cormorant (PECO) success was below average at St. Lazaria Island, average at Round Island and above average at the remaining four colonies in 2008 (Table 34). We found a decline of red-faced cormorants at Chiniak Bay in all years and an increase there since 1999 (Table 35). When all years were included, pelagic cormorants showed negative trends, stable numbers and increases at two sites each (Table 35). In the last decade, pelagic cormorants declined at three sites and increased at two colonies. Over all years, unidentified cormorant (UNCO) populations were stable at two of the three monitored colonies, and declining at Ulak Island. Unidentified cormorant numbers

Table 33. Seabird relative breeding chronology[a] compared to averages for past years. Only sites for which there were data from 2008 are included.

Region	Site	FTSP[b]	LESP	RFCO	GWGU	BLKI	RLKI	COMU	TBMU	ANMU	PAAU	LEAU	WHAU	CRAU	HOPU	TUPU
N. Bering/ Chukchi	Bluff					–										
SE Bering	St. Paul I.			+		–	–	=	=							
	St. George I.					–	–	=	–							
	Aiktak I.	=	=		=			=		=					=	–
SW Bering	Buldir I.					–	–		=		+	=	=	=	+	–
	Kiska I.											=		=		
	Kasatochi I.											=		=		
Gulf of Alaska	E. Amatuli I.					–		+								
Southeast	St. Lazaria I.	–	=		=			=	+							

[a] Codes:
"– " indicates hatching chronology was > 3 days earlier than the average for this site.
"=" indicates hatching chronology was within 3 days of average.
"+" indicates hatching chronology was > 3 days later than the average for this site.

[b] FTSP=fork-tailed storm-petrel, LESP=Leach's storm-petrel, RFCO=red-faced cormorant, GWGU=glaucous-winged gull, BLKI=black-legged kittiwake, RLKI=red-legged kittiwake, 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 34. Seabird relative productivity levels[a] compared to averages for past years. Only sites for which there were data from 2008 are included.

Region	Site	FTSP[b]	LESP	RFCO	PECO	GWGU	BLKI	RLKI	COMU	TBMU	ANMU	PAAU	LEAU	WHAU	CRAU	HOPU	TUPU
N. Bering/ Chukchi	C. Lisburne						=										
	St. Lawrence I.						–		=	=			–		–		
	Bluff				+		–										
SE Bering	St. Paul I.			+			–	+	–	–							
	St. George I.			–			–	+	=	=							
	Round I.				=		+		+								
	Aiktak I.	=	=	=	+	–			–	+	=					+	+
SW Bering	Buldir I.	=	=	=	+	+	+	+	+	=		=	+	+	+	=	+
	Kiska I.												+		=		
	Kasatochi I.	–			+												
Gulf of Alaska	E. Amatuli I.						+										
	Pr. William Snd.						–										
Southeast	St. Lazaria I.	+	=		–	+			=	=							

[a] Codes:
"– " indicates productivity was > 20% below the average for this site.
"=" indicates productivity was within 20% of average.
"+" indicates productivity was > 20% above the average for this site.

[b] FTSP=fork-tailed storm-petrel, LESP=Leach's storm-petrel, RFCO=red-faced cormorant, PECO=pelagic cormorant, GWGU=glaucous- winged gull, BLKI=black-legged kittiwake, RLKI=red-legged kittiwake, 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 population trends[a] for all available years, with the trend from the past decade (1999-2008) in parentheses. Cell color indicates trend over all years.

Region	Site	NOFU[b]	STPE	RFCO	PECO	UNCO	GWGU	BLKI	RLKI	COMU	TBMU	UNMU	PIGU	LEAU	CRAU	RHAU	TUPU
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.	= (+)						= (+)				= (+)					
	Chiniak Bay			– (+)	– (+)												
	E. Amatuli I.		= (=)														– (–)
	P. William Snd							= (=)					– (N/A)				
	Middleton I.				– (–)		+ (=)	– (–)				– (–)					
Southeast	St. Lazaria I.		= (=)		+ (–)		+ (+)					= (=)	= (–)			+ (+)	– (=)

[a]Codes:
"– " indicates a negative population trend of >=3% per annum for this site.
"=" indicates no population trend.
"+" indicates 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, STPE=storm-petrel, RFCO=red-faced cormorant, PECO=pelagic cormorant, UNCO= unspecified cormorant, GWGU=glaucous- winged gull, BLKI=black-legged kittiwake, RLKI=red-legged kittiwake, 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.

have declined at all three colonies since 1999 (Table 35).

Overall, pigeon guillemot (PIGU) numbers showed a decline in Prince William Sound, but no trends at Buldir, Kasatochi or St. Lazaria islands (Table 35). This species declined between 1999 and 2008 at Buldir and St. Lazaria islands.

Diving fish-feeders (offshore).–Timing of common murre (COMU) hatching in 2008 was average at four colonies and late at one site (Table 33). Thick-billed murre (TBMU) chronology was early at one site, average at two colonies and late at one location in 2008.

Common and thick-billed murres exhibited average or below average reproductive success at all but three monitored sites in 2008, the exceptions being above average productivity of common murres at Round and Buldir islands, and thick-billed murres at Aiktak Island (Table 34).

In all years, numbers of common murres showed declines at St. Paul Island and Cape Peirce, remained stable at three locations and increased at Round Island (Table 35). Common murre numbers exhibited declines at St. George Island, no trends at three sites and an increase at Round Island in the last decade. 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 have remained stable in recent years at the Pribilof Islands, and continue to increase at Round 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 35). Since 1999, murre populations have declined at two sites, showed no trends at two colonies and increased at three locations.

Ancient murrelet (ANMU) hatching chronology and productivity were average at Aiktak Island in 2008 (Tables 33and 34).

We found an increase in the number of rhinoceros auklet burrows at St. Lazaria Island, both overall and in the last decade (Table 35).

Horned puffins (HOPU) exhibited normal or late hatching chronology, and average or higher than average productivity at the two monitored sites in 2008 (Tables 33 and 34).

Tufted puffin (TUPU) eggs hatched earlier than average at Buldir and Aiktak islands in 2008 (Table 33). Reproductive success for this species was above average at Buldir and Aiktak islands in 2008 (Table 34). Tufted puffin populations increased at Bogoslof Island, declined at E. Amatuli and St. Lazaria islands, and showed no trend at Aiktak Island in all years (Table 35). Since 1999, tufted puffin numbers have been stable at three sites and continued to decline at East Amatuli Island.

Diving plankton-feeders.–Least (LEAU), whiskered (WHAU) and crested (CRAU) auklets had average nesting chronologies at all sites where they were monitored in 2008, whereas parakeet auklets (PAAU) were late at Buldir Island (Table 33). With two exceptions, parakeet, least, whiskered and crested auklets had average or above average success at all monitored sites in 2008. Least and crested auklet productivity was below average at St. Lawrence Island in 2008 (Table 34). Least auklet populations declined at Kasatochi Island and were stable at St. George Island during all years as well as since 1999. Crested auklet numbers were stable during both time periods at Kasatochi Island (Table 35).

Regional differences

Northern Bering/Chukchi.–Black-legged kittiwake hatching chronology was early at Bluff in 2008 (Table 33). Since data were available only for this species in this region in 2008, regional chronology also was early in 2008 (Table 36).

Pelagic cormorants exhibited above average productivity at Bluff in 2008 (Table 34). Reproductive success was below average for black-legged kittiwakes at St. Lawrence Island and Bluff, and average at Cape Lisburne. Murre productivity was average at St. Lawrence Island in 2008, whereas least and crested auklets exhibited low success there. Overall, seabirds breeding in the northern Bering/Chukchi region had average productivity in 2008 (Table 37).

When all years were considered, we found declining trends in two of nine instances (species x site) in this region, stable populations in five instances and increases for two species at Cape Lisburne (Table 35). There were insufficient data to determine recent trends at Hall Island. Three of the four instances with adequate recent data showed stable populations since 1999, and an increase in black-legged kittiwake numbers at Cape Lisburne during the last decade. Overall, we found that populations were stable between 1999 and 2008 in the northern Bering/Chukchi region (Table 38).

Southeastern Bering.–Fork-tailed and Leach's storm-petrel hatching chronology was average, and cormorants exhibited later than average hatching chronology in this region in 2008 (Table 33). Glaucous-winged gull chronology was average, whereas kittiwake hatching was early at all monitored colonies. Timing of common murre hatching was average throughout the region. Thick-billed murres were early at St. George Island and average at St. Paul Island. Ancient murrelet hatching was average at Aiktak Island. Horned puffin hatching chronology was average at Aiktak Island in 2008, whereas tufted puffins hatched early there. Overall, seabirds breeding in the southeastern Bering region exhibited average chronology in 2008 (Table 36).

Storm-petrel reproductive success was average in this region in 2008 (Table 34). Cormorants experienced average or above average productivity region wide, with the exception of below average success of red-faced cormorants at St. George Island. Gulls and kittiwakes exhibited lower than normal productivity in three of six instances in this region in 2008, and above average productivity at three sites. Murre productivity was average or below average at most monitored colonies, and above average at Round and Aiktak islands. Ancient murrelets and puffins exhibited average or above average productivity at Aiktak Island in 2008. Overall, seabirds breeding in the southeastern Bering region had average productivity in 2008 (Table 37).

When all years were considered, we found negative population trends in five of 23 cases (species x site), stable populations in 16 instances and increases in two cases (Table 35). Breeding seabird populations declined in five of 22 instances, were stable in 11 cases and exhibited increasing trends in six instances in this region during the last decade. We found that, overall, populations were stable between 1999 and 2008 in the southeastern Bering region (Table 38).

Southwestern Bering.–Kittiwake hatch dates were earlier than average and thick-billed murre hatching was average at Buldir Island in 2008 (Table 33). Plankton-feeders (auklets) exhibited average breeding chronology in seven of eight instances in this region in 2008, and late timing in one instance. Horned puffin chronology was later than average at Buldir Island, and tufted puffins exhibited early

Table 36. Regional and statewide seabird breeding chronology[a] compared to averages for past years within regions and the state of Alaska as a whole. Chronology was calculated for each species in a region using data from all colonies. Each colony was weighted equally within each region, and each species carried equal weight in calculating the statewide average. The chronology was averaged for all sites within each region resulting in a value for each species and a value for all species within each region. Species chronologies were then averaged to calculate a value for the entire state. Only sites for which there were data from 2008 are included.

Region	FTSP[b]	LESP	RFCO	GWGU	BLKI	RLKI	COMU	TBMU	ANMU	PAAU	LEAU	WHAU	CRAU	HOPU	TUPU	**ALL**[c]
N. Bering/ Chukchi					–											–
SE Bering	=	=	+	=	–	–	=	–	=					=	–	=
SW Bering					–	–		=		+	=	=	=	+	–	=
N. Gulf of Alaska					–		+									=
Southeast	–	=		=			=	+								=
Alaska	–	=	+	=	–	–	=	=	=	+	=	=	=	+	–	=

[a] Codes:
"– " indicates hatching chronology was > 3 days earlier than the average for this site or region.
"=" indicates hatching chronology was within 3 days of average.
"+" indicates hatching chronology was > 3 days later than the average for this site or region.

[b] FTSP=fork-tailed storm-petrel, LESP=Leach's storm-petrel, RFCO=red-faced cormorant, GWGU=glaucous-winged gull, BLKI=black-legged kittiwake, RLKI=red-legged kittiwake, 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 37. Regional and statewide seabird productivity levels[a] compared to averages for past years within regions and the state of Alaska as a whole. Productivity was calculated for each species in a region using data from all colonies. Each colony was weighted equally within each region, and each species carried equal weight in calculating the statewide average. The productivity was averaged for all sites within each region resulting in a value for each species and a value for all species within each region. Species productivities were then averaged to calculate a value for the entire state. Only sites for which there were data from 2008 are included.

Region	FTSP[b]	LESP	RFCO	PECO	GWGU	BLKI	RLKI	COMU	TBMU	ANMU	PAAU	LEAU	WHAU	CRAU	HOPU	TUPU	**ALL**
N. Bering/ Chukchi				+		–		=	=			–		–			=
SE Bering	=	=	=	+	–	=	+	=	=	=					+	+	=
SW Bering	=	=	=	+	+	+	+	+	=		=	+	+	=	=	+	+
Gulf of Alaska						=											=
Southeast	+	=		–	+			=	=								=
Alaska	=	=	=	+	+	=	+	=	=	=	=	=	+	=	+	+	+

[a] Codes:
"– " indicates productivity was > 20% below the average for the region or the state of Alaska.
"=" indicates productivity was within 20% of average.
"+" indicates productivity was > 20% above the average for the region or the state of Alaska.

[b] FTSP=fork-tailed storm-petrel, LESP=Leach's storm-petrel, RFCO=red-faced cormorant, PECO=pelagic cormorant, GWGU=glaucous-winged gull, BLKI=black-legged kittiwake, RLKI=red-legged kittiwake, 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 38. Regional and statewide seabird population trends[a] during the last decade (1999-2008) within regions and the state of Alaska as a whole. Population trends were calculated for each species in a region using data from all colonies. Each colony was weighted equally within each region, and each species carried equal weight in calculating the statewide average. Trends (line slopes) were averaged for all sites within each region resulting in a value for each species and a value for all species within each region. Species populations were then averaged to calculate a value (slope) for the entire state. Only sites for which there were data from at least two years (at least 5 years apart) within the last decade are included.

Region	NOFU[b]	FTSP	STPE	RFCO	PECO	UNCO	GWGU	BLKI	RLKI	COMU	TBMU	UNMU	PIGU	LEAU	CRAU	RHAU	TUPU	**ALL**
N. Bering/ Chukchi								=		=		=						=
SE Bering	=		=		–	–	+	=	–	=	=	+		=			=	=
SW Bering					+	–	+	=	=		+	=	–	–	=			=
Gulf of Alaska	+	=		+	+		=	=				=					–	=
Southeast			=		–		+					=	–			+	=	=
Alaska	=	=	=	+	=	–	+	=	=	=	+	=	–	–	=	+	=	=

[a]Codes:
"– " indicates a negative population trend of >=3% per annum for this site or region.
"=" indicates no population trend.
"+" indicates 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, RFCO=red-faced cormorant, PECO=pelagic cormorant, UNCO=unspecified cormorant, GWGU=glaucous-winged gull, BLKI=black-legged kittiwake, RLKI=red-legged kittiwake, 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.

hatching chronology at that colony in 2008. Overall, seabirds breeding in the southwestern Bering region exhibited average chronology in 2008 (Table 36).

Storm-petrels exhibited average or below average productivity in this region in 2008 (Table 34). Cormorant success was average or above average. Glaucous-winged gulls and black- and red-legged kittiwakes had above average productivity at Buldir Island, and murre productivity was average or above average there. Auklets and puffins exhibited average or above average productivity at monitored colonies in this region in 2008. Overall, seabirds breeding in the Southwestern Bering region had above average productivity in 2008 (Table 37).

When all years were considered, we found negative population trends in three of 15 cases (species x site), stable populations in seven instances and increases in five cases (Table 35). Breeding seabird populations declined in seven of 14 instances, were stable in two cases and exhibited increasing trends in five instances in this region during the last decade. We found that, overall, populations were stable between 1999 and 2008 in the southwestern Bering region (Table 38).

Northern Gulf of Alaska.–Breeding chronology was early for black-legged kittiwakes and late for common murres breeding in this region in 2008 (Table 33). Overall, seabirds breeding in the nothern Gulf of Alaska region exhibited average chronology in 2008 (Table 36).

Black-legged kittiwake productivity was above average at East Amatuli Island and below average in Prince William Sound in 2008 (Table 34). Overall, seabirds breeding in the northern Gulf of Alaska region had average productivity in 2008 (Table 37).

When all years were considered, we found negative population trends in seven of 13 cases (species x site), stable populations in five instances and increases in one case (Table 35). Breeding seabird populations declined in four of 12 instances, were stable in three cases and exhibited increasing trends in five instances in this region during the last decade. We found that, overall, populations were stable between 1999 and 2008 in the northern Gulf of Alaska region (Table 38).

Southeast Alaska.–Hatch dates were early for fork-tailed storm-petrels, average for Leach's storm-petrels, glaucous-winged gulls and common murres, and late for thick-billed murres at St. Lazaria Island in 2008 (Table 33). Overall, seabirds breeding in the southeast Alaska region exhibited average chronology in 2008 (Table 36).

Pelagic cormorants exhibited below average success in this region in 2008, whereas storm-petrels, glaucous-winged gulls and murres had average or above average productivity (Table 34). Overall, seabirds breeding in the southeast Alaska region had average productivity in 2008 (Table 37).

When all years were considered, we found negative population trends in one of seven cases (species x site), stable populations in three instances and increases in three cases. (Table 35). Breeding seabird populations declined in two of seven instances, were stable in three cases and exhibited increasing trends in two instances in this region during the last decade. We found that, overall, populations were stable between 1999 and 2008 in the southeast Alaska region (Table 38).

Statewide Summary

Breeding chronology.–When we combined the departure from the average site hatching chronology for all regions where a species nested, we found that timing was early for four species, average for eight species and late for three species in 2008 (Table 36). When these departures were

averaged for all species within the state, we determined that, overall, Alaska seabird breeding chronology was average in 2008.

Productivity.–When we combined the percent difference from the average site productivity for all regions where a species nested, we found that productivity was average for 10 species and above average for six species in 2008 (Table 37). When these percentages were averaged for all species within the state, we determined that, overall, seabirds exhibited above average productivity in Alaska in 2008.

Populations.–When we averaged the population trends for the last decade (1999-2008) for all regions where a species nested, we found that three species showed declining trends, 10 species were stable and four species were increasing (Table 38). When these trends were averaged for all species within the state, we determined that, overall, Alaskan seabird populations were stable between 1999 and 2008.

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Appendix 1. Masses of prey items used to estimate biomass for planktivore diet graphs (see Figs. 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 Figs. 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 Figs. 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