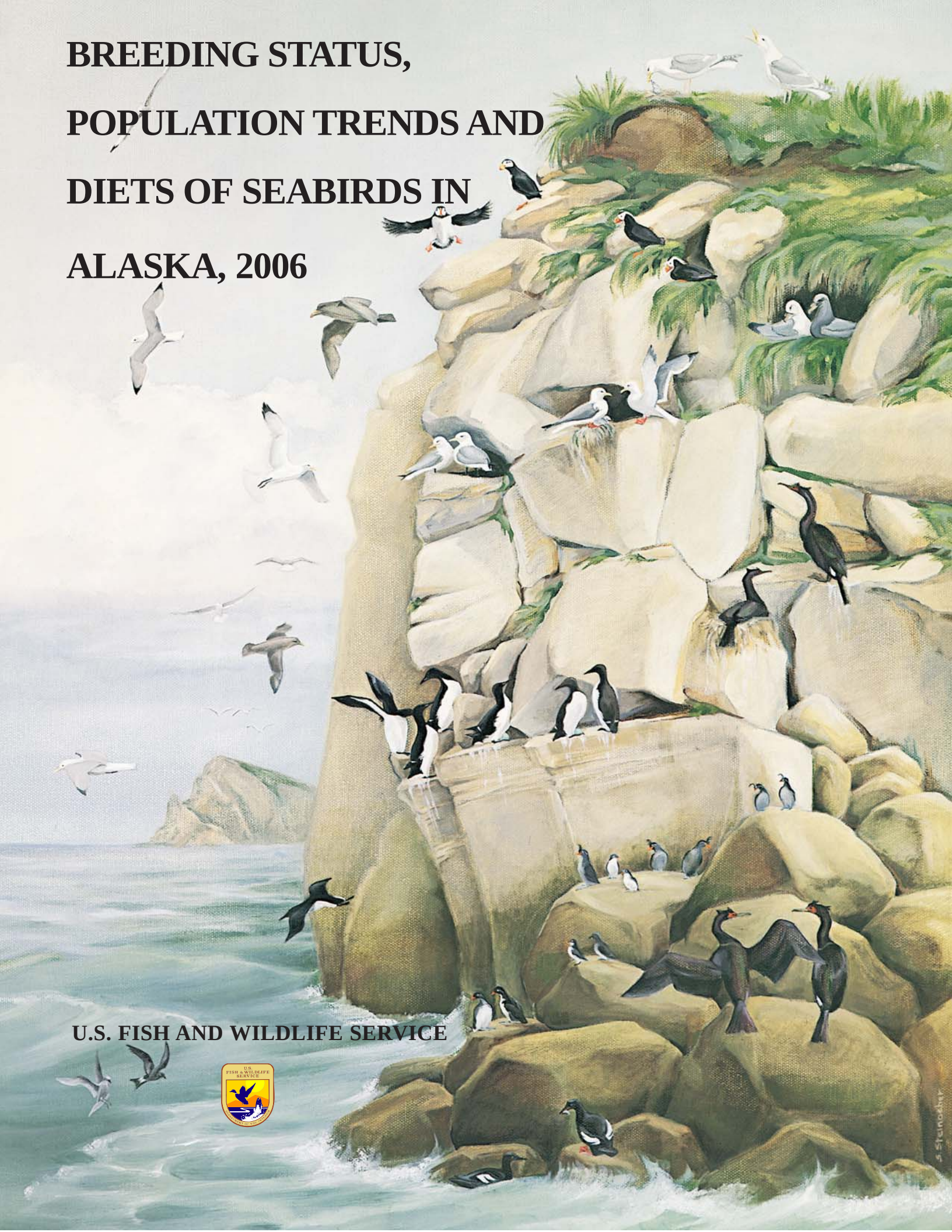
BREEDING STATUS, POPULATION TRENDS AND DIETS OF SEABIRDS IN ALASKA, 2006



U.S. FISH AND WILDLIFE SERVICE

AMNWR 09/05

BREEDING STATUS, POPULATION TRENDS AND DIETS OF SEABIRDS IN ALASKA, 2006

Compiled By:

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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 eleventh 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 2006 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 and one annual monitoring site on the Togiak 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 2006, most species exhibited average or later than average nesting phenology. Timing of nesting of plankton feeders (storm-petrels and auklets) was normal or late in all but one case. Fish feeders (cormorants, gulls, kittiwakes, murres, murrelets, rhinoceros auklets, puffins) were earlier than normal in 6 of 35 cases (species x site), late in 14 cases and about normal in 15 cases.

Plankton feeders had average or above average rates of reproductive success in 14 of 17 cases in 2006, the exceptions being below average productivity of Leach's storm-petrels at St. Lazaria Island, and of least and crested auklets at St. Lawrence Island. Fish feeders had below average, average and above average productivity in approximately equal proportions in 2006. There were fewer instances of low productivity in the Southwestern Bering Sea and Gulf of Alaska regions than in the other regions.

Storm-petrel populations were increasing at St. Lazaria Island and stable at the remaining two sites. Populations of fish feeders (northern fulmars, cormorants, gulls, kittiwakes, murres, pigeon guillemots, rhinoceros auklets, puffins) exhibited stable populations in 34 of 67 cases (species x site). We found significant upward trends in 13 cases and significant declines in 20 cases. No geographic patterns were apparent with regard to population trends of Alaskan seabirds.

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Introduction

This report is the eleventh 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, 2006, 2007 and 2008 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, by providing 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 (Fig. 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 2006. Furthermore, data are recorded annually or semiannually at other sites in Alaska (e.g., Cape Peirce, Togiak NWR). In addition, colonies near the annual sites are identified for less frequent surveys to "calibrate" the information at the annual sites. Data provided from other research projects (e.g., those associated with evaluating the impacts of invasive rodents on marine birds) also supplement the monitoring database.

In this report, we summarize information from 2006 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.

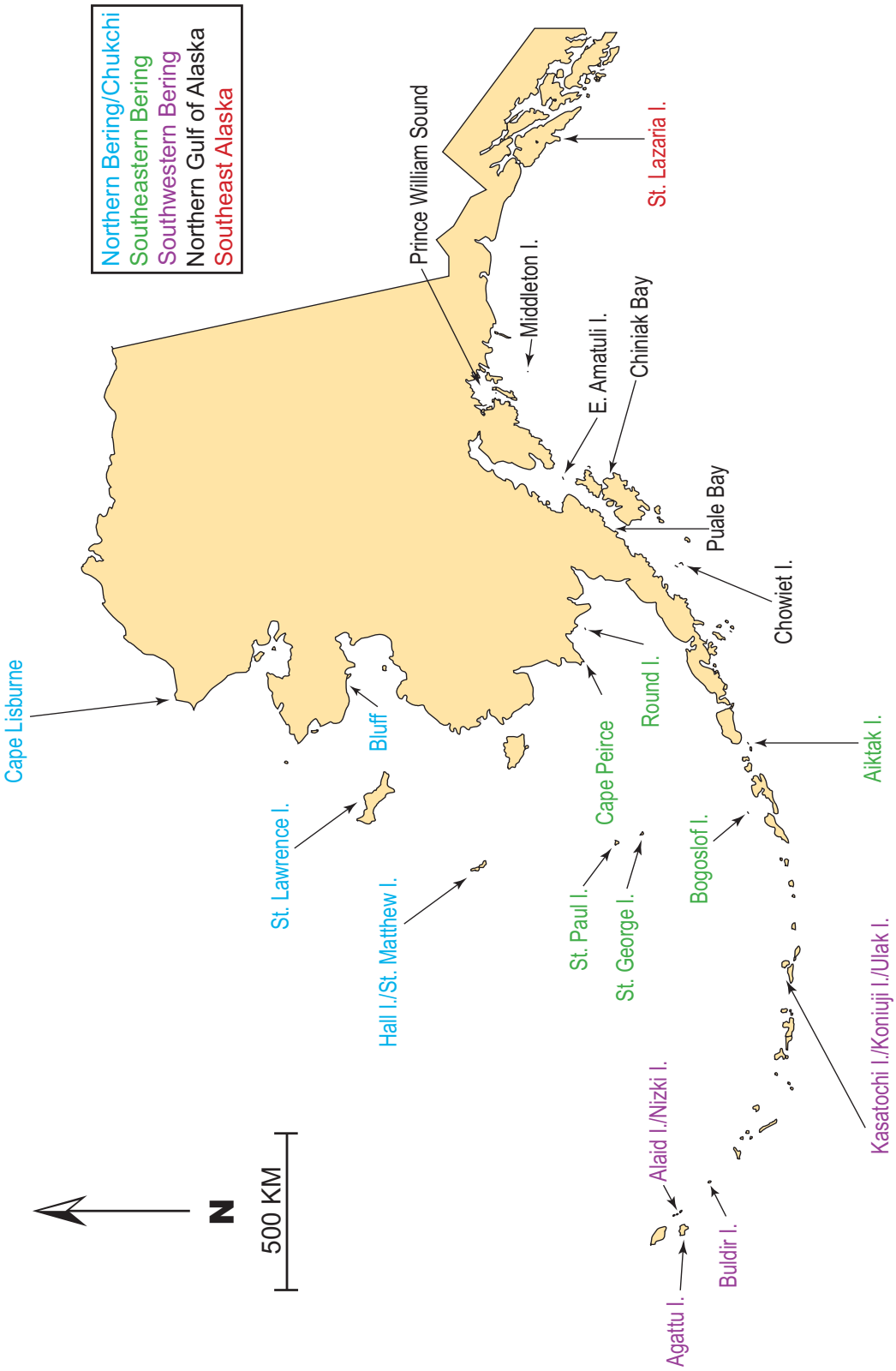


Figure 1. Map of Alaska showing the locations of seabird monitoring sites summarized in this report. Text colors indicate georgaphic regions.

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 2006, and compares 2006 results with previous years. For sites with at least two years of data prior to 2006, site averages were used for comparisons. Otherwise, prior estimates for nearby sites were utilized 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. Overall population trends were analyzed using linear regression models on log-transformed data (ln). Trends were considered to be significant at the $p<0.05$ level and are reported as percent per annum increase or decline. Care should be taken to note respective sample sizes when comparing population trends at different colonies. A significant trend at a small colony will have less impact at a regional or population level than a similar rate of change at a much larger colony.

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 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.

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 2006.

Productivity.–No data for 2006.

Populations.–We found no significant trends for northern fulmars at any monitored colony (Figure 2).

Diet.–No data.

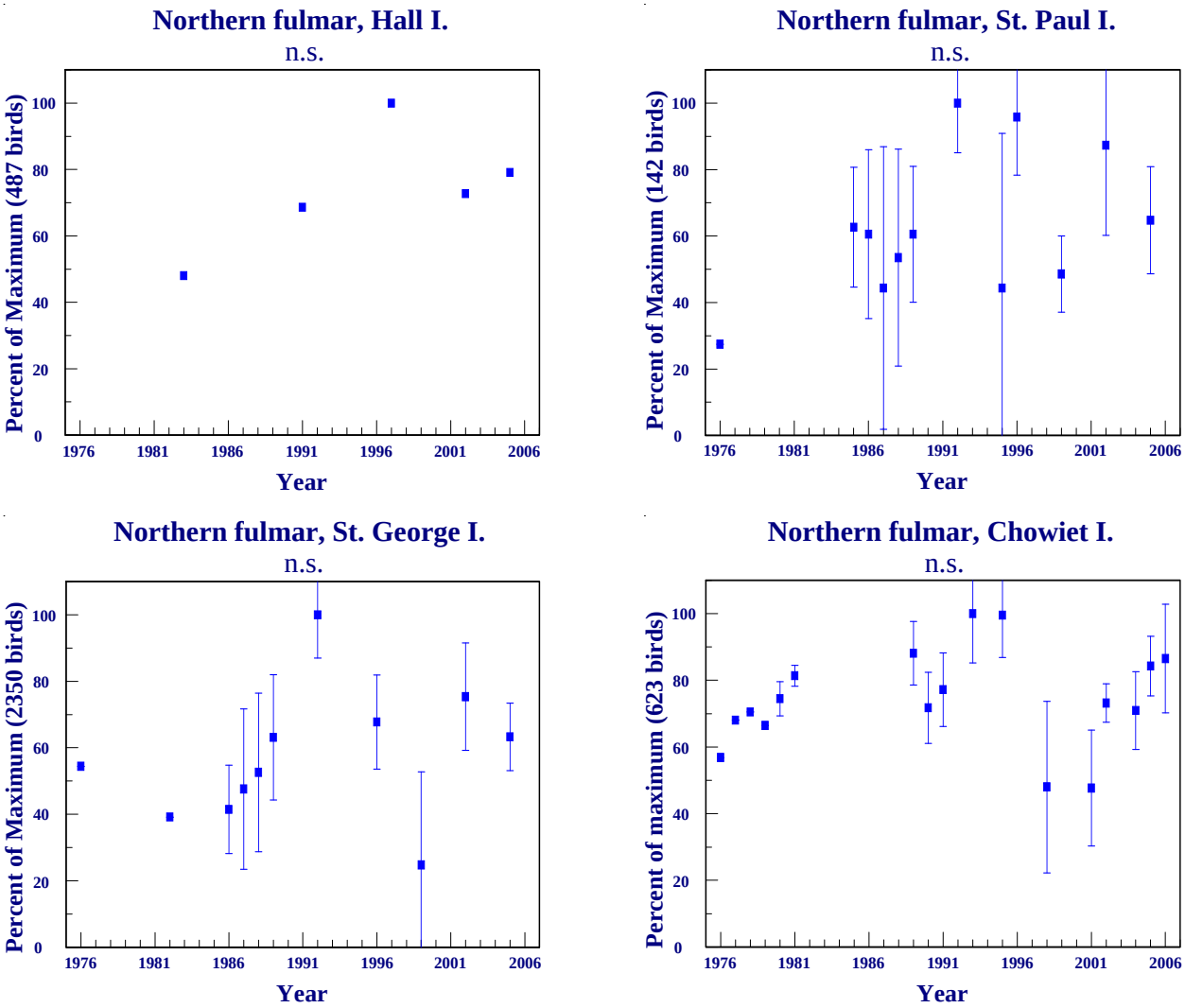


Figure 2. Trends in populations of northern fulmars at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Significance of trends indicated as: n.s. p>= 0.05 (not significant), * p<0.05, ** p<0.01, *** p<0.001.

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

Breeding chronology.–The mean hatch date for fork-tailed storm-petrels was about average at Aiktak and St. Lazaria islands in 2006 (Table 2, Fig. 3).

Table 2. Hatching chronology of fork-tailed storm-petrels at Alaskan sites monitored in 2006.

Site	Median	Mean	Long-term Average	Reference
Aiktak I.	18 Jul (20)[a]	16 Jul (20)	16 Jul[b] (9)[a]	Helm and Zeman 2006
St. Lazaria I.	—	14 Jul (36)	15 Jul[b] (11)	Slater and Byrd 2009

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

Productivity.–In 2006, productivity of fork-tailed storm-petrels was about average at all monitored sites, except Kasatochi where success was above average (Table 3, Fig. 4).

Table 3. Reproductive performance of fork-tailed storm-petrels at Alaskan sites monitored in 2006.

Site	Chicks Fledged[a]/Egg	No. of Plots	Long-term Average	Reference
Buldir I.	0.86	5 (57)[b]	0.72 (20)[b]	Orben et al. 2006
Ulak I.	0.67	1 (43)	0.63 (10)	Buchheit and Ford 2008
Kasatochi I	0.82	N/A[c] (104)	0.57 (2)	Buchheit and Ford 2008
Aiktak I.	0.81	13 (48)	0.84 (6)	Helm and Zeman 2006
St. Lazaria I.	0.51	8 (173)	0.63 (10)	Slater and Byrd 2009

[a]Fledged chick defined as being still 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. Storm-petrel populations increased by 1.1% per annum at St. Lazaria Island (Fig. 5). No other monitored colonies exhibited significant trends.

Diet.–Diets of fork-tailed storm petrels at Buldir and Kasatochi islands consisted of a majority of myctophids and amphipods (Fig. 6). In a small sample from Aiktak Island, diet consisted entirely of amphipods and sand lance. Diets from St. Lazaria Island consisted of a majority of myctophids and other larval fish.

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.

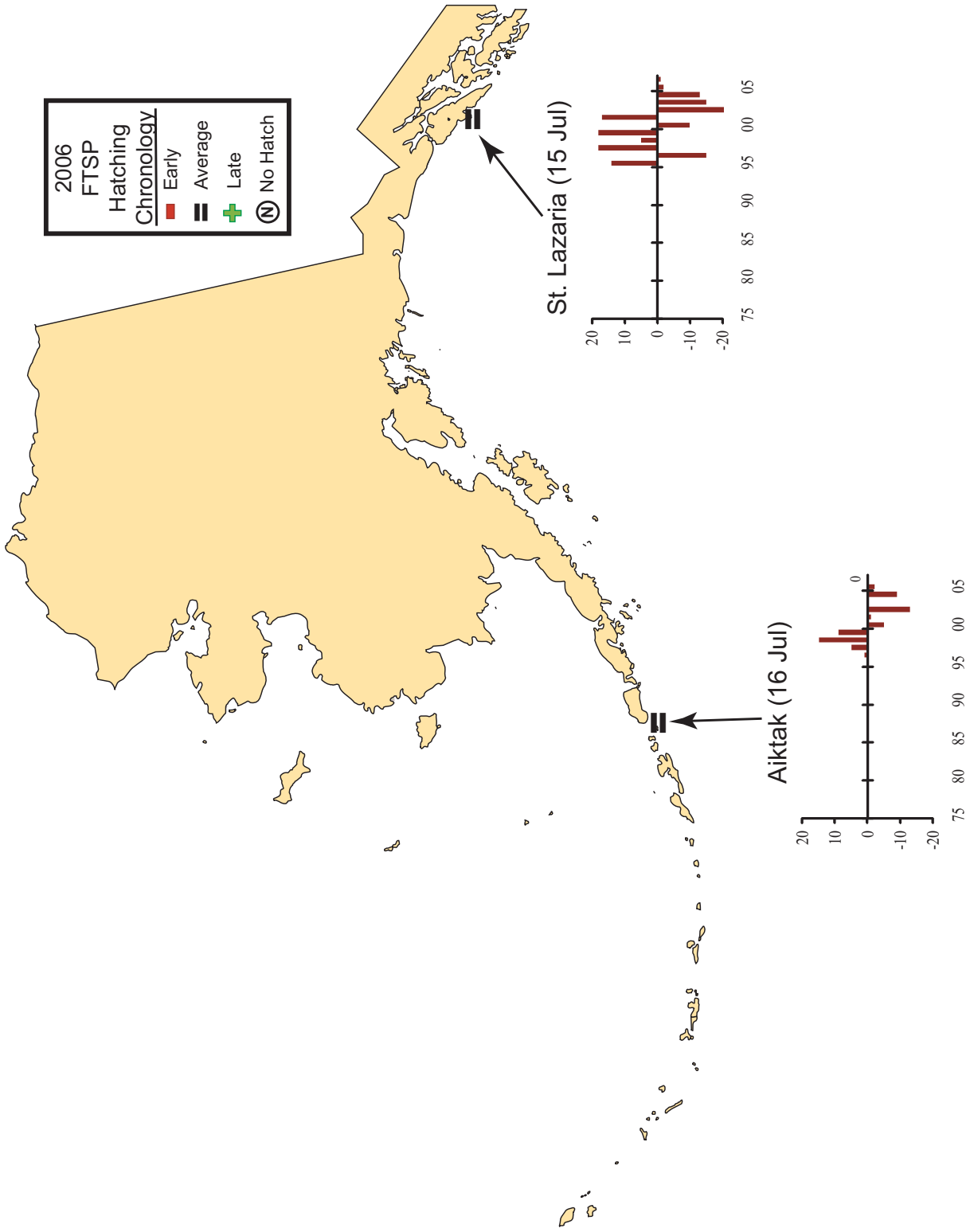


Figure 3. Hatching chronology of fork-tailed storm-petrels at Alaskan sites monitored in 2006. Graphs indicate the departure in days (if any), from the site mean (in parentheses; current year not included).

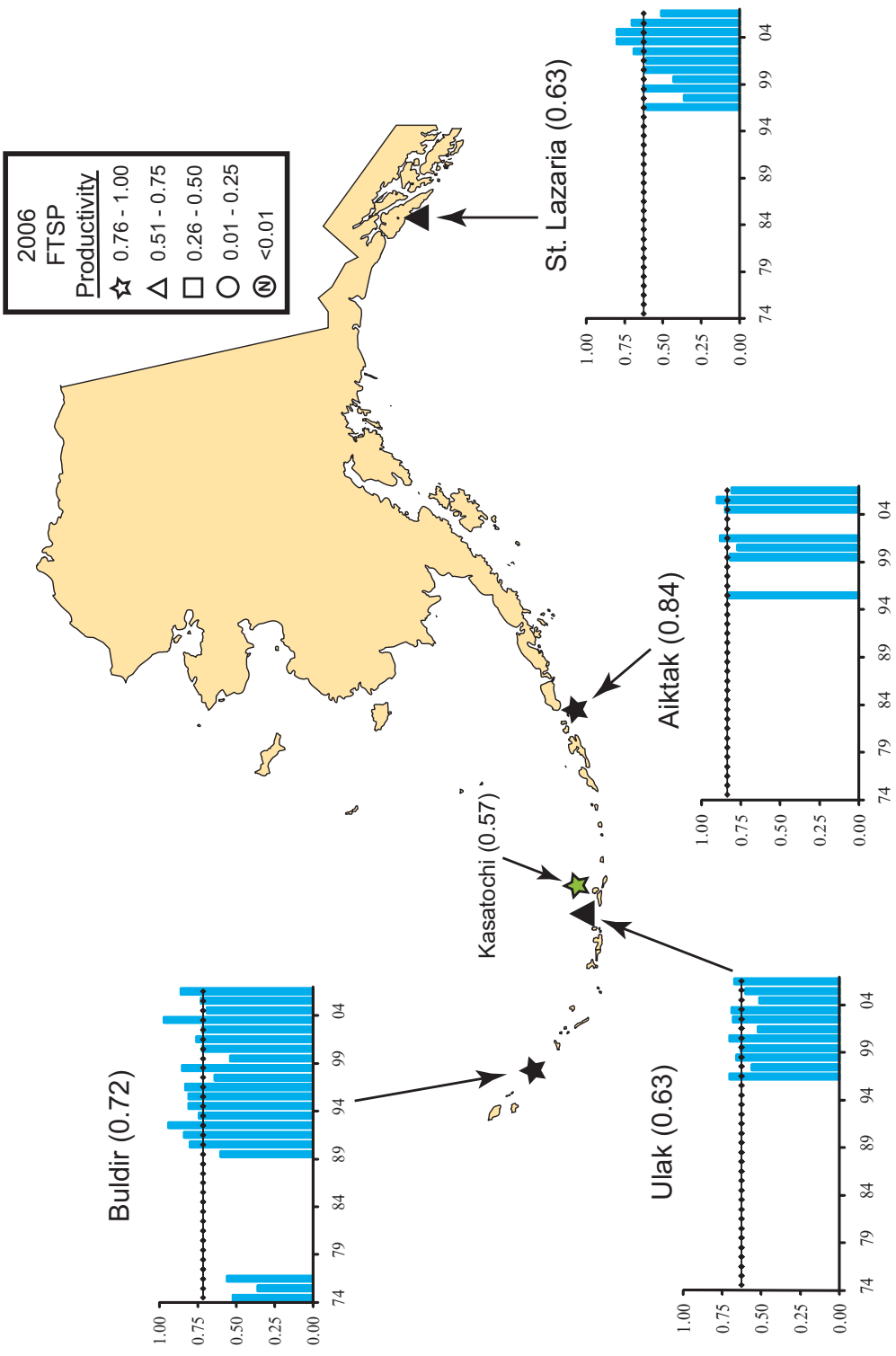


Figure 4. Productivity of fork-tailed storm-petrels (chicks fledged/egg) at Alaskan sites monitored in 2006. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is > 20% above site mean).

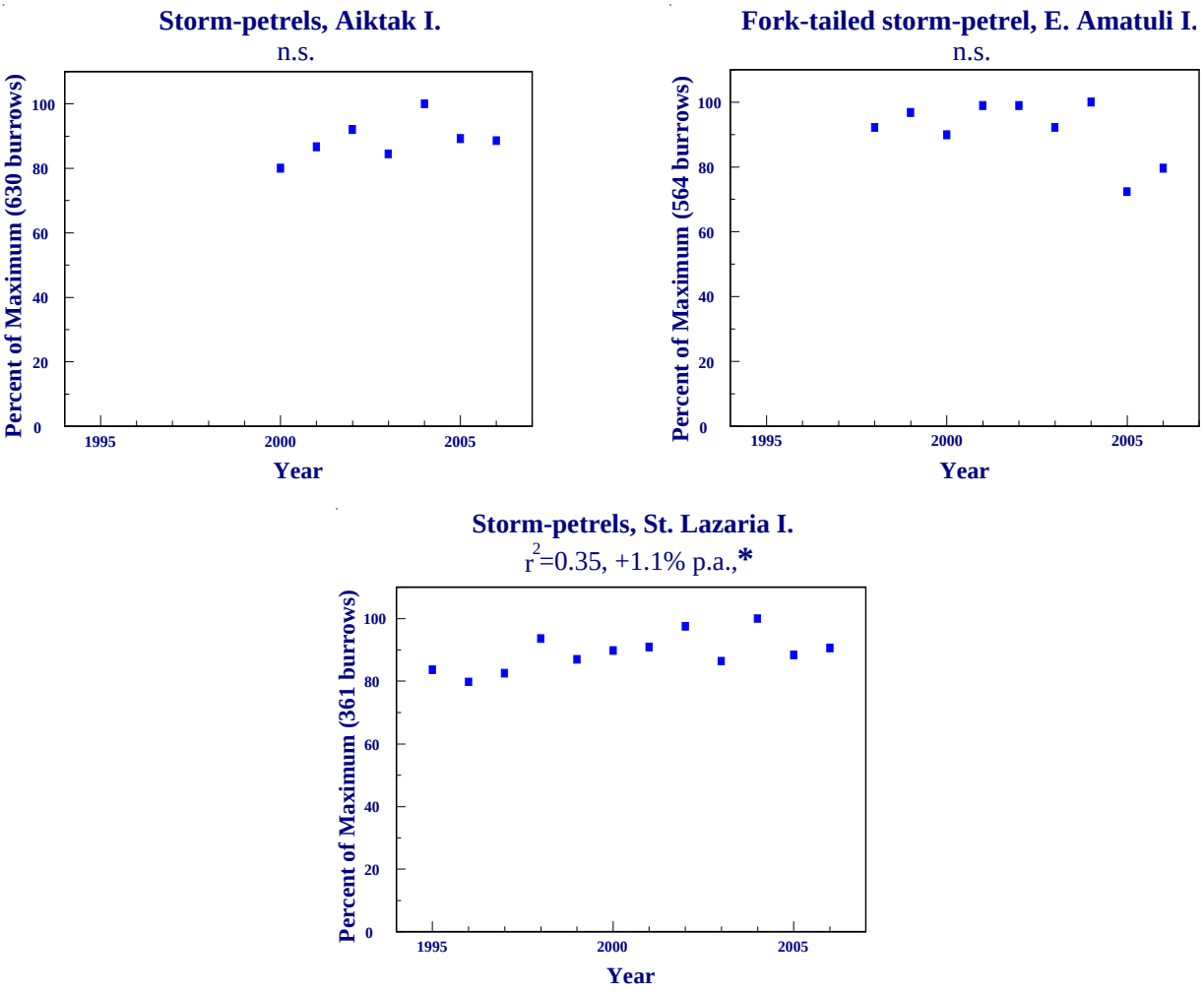


Figure 5. Trends in populations of storm-petrels at Alaskan sites. Significance of trends indicated as: n.s. p>= 0.05 (not significant), * p<0.05, ** p<0.01, *** p<0.001. Rates of increase or decline are reported as percent change per annum (p.a.).

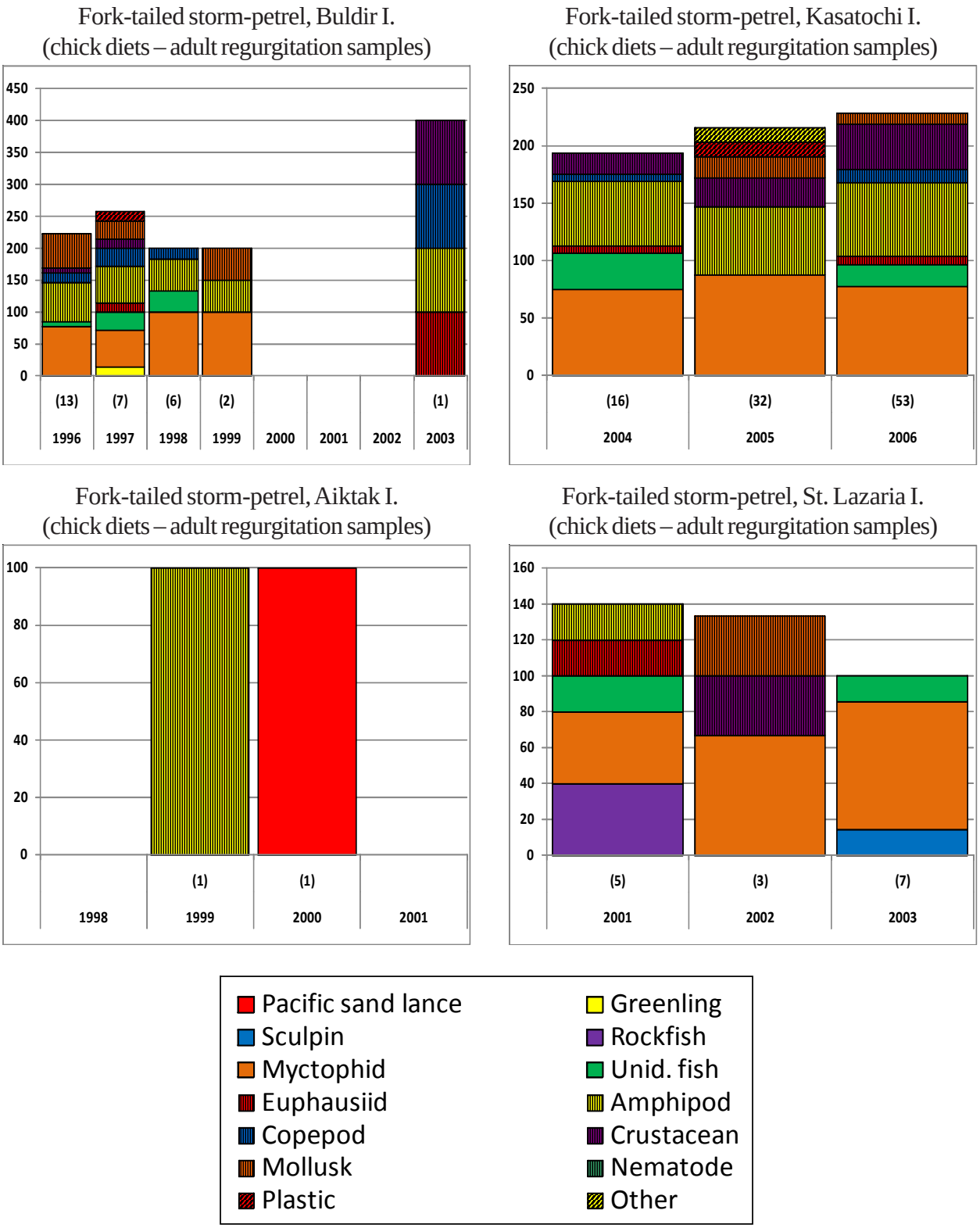


Figure 6. Diets of fork-tailed storm-petrels at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

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

Breeding chronology.–The mean hatch date for Leach's storm-petrels was about average at Aiktak and St. Lazaria islands in 2006 (Table 4, Fig. 7).

Table 4. Hatching chronology of Leach's storm-petrels at Alaskan sites monitored in 2006.

Site	Median	Mean	Long-term Average	Reference
Aiktak I.	30 Jul (34)[a]	1 Aug (34)	1 Aug[b] (9)[a]	Helm and Zeman 2006
St. Lazaria I.	—	29 Jul (20)	31 Jul[b] (11)	Slater and Byrd 2009

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

Productivity.–In 2006, productivity of Leach's storm-petrels was about average at Buldir and Aiktak islands, and below average at St. Lazaria Island (Table 5, Fig. 8).

Table 5. Reproductive performance of Leach's storm-petrels at Alaskan sites monitored in 2006.

Site	Chicks Fledged[a]/Egg	No. of Plots	Long-term Average	Reference
Buldir I.	0.82	5 (72)[b]	0.74 (20)[b]	Orben et al. 2006
Aiktak I.	0.90	13 (69)	0.84 (6)	Helm and Zeman 2006
St. Lazaria I.	0.24	8 (149)	0.62 (10)	Slater and Byrd 2009

[a]Fledged chick defined as being still 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. Storm-petrel populations increased by 1.1% per annum at St. Lazaria Island (Fig. 5). No other monitored colonies exhibited significant trends.

Diet.–Diets of Leach's storm petrels at Buldir and St. Lazaria islands consisted of a majority of larval fish and small crustaceans (Fig. 9). In a small sample from Aiktak Island, diet consisted entirely of fish.

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.

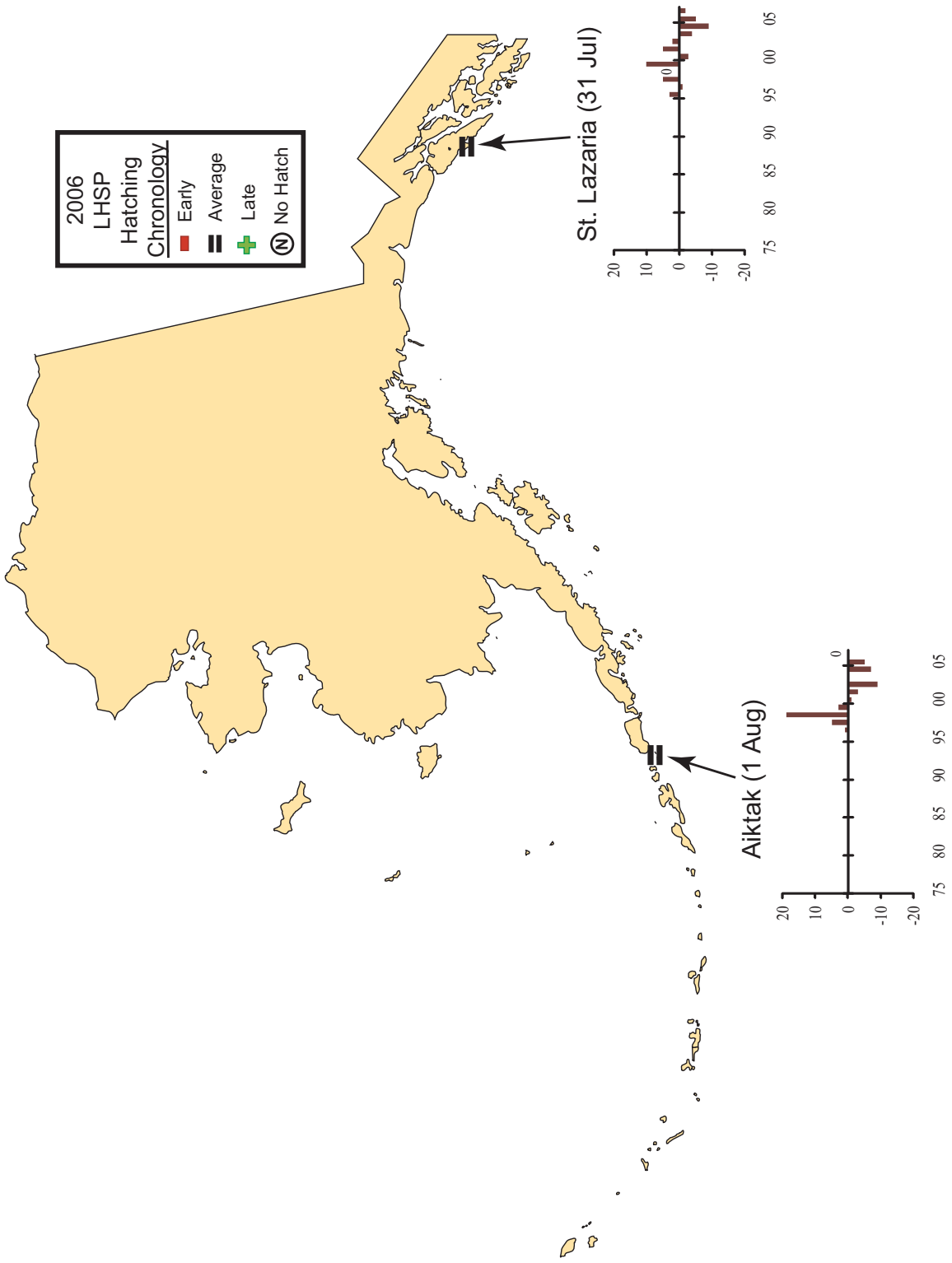


Figure 7. Hatching chronology of Leach's storm-petrels at Alaskan sites monitored in 2006. Graphs indicate the departure in days (if any), from the site mean (in parentheses; current year not included).

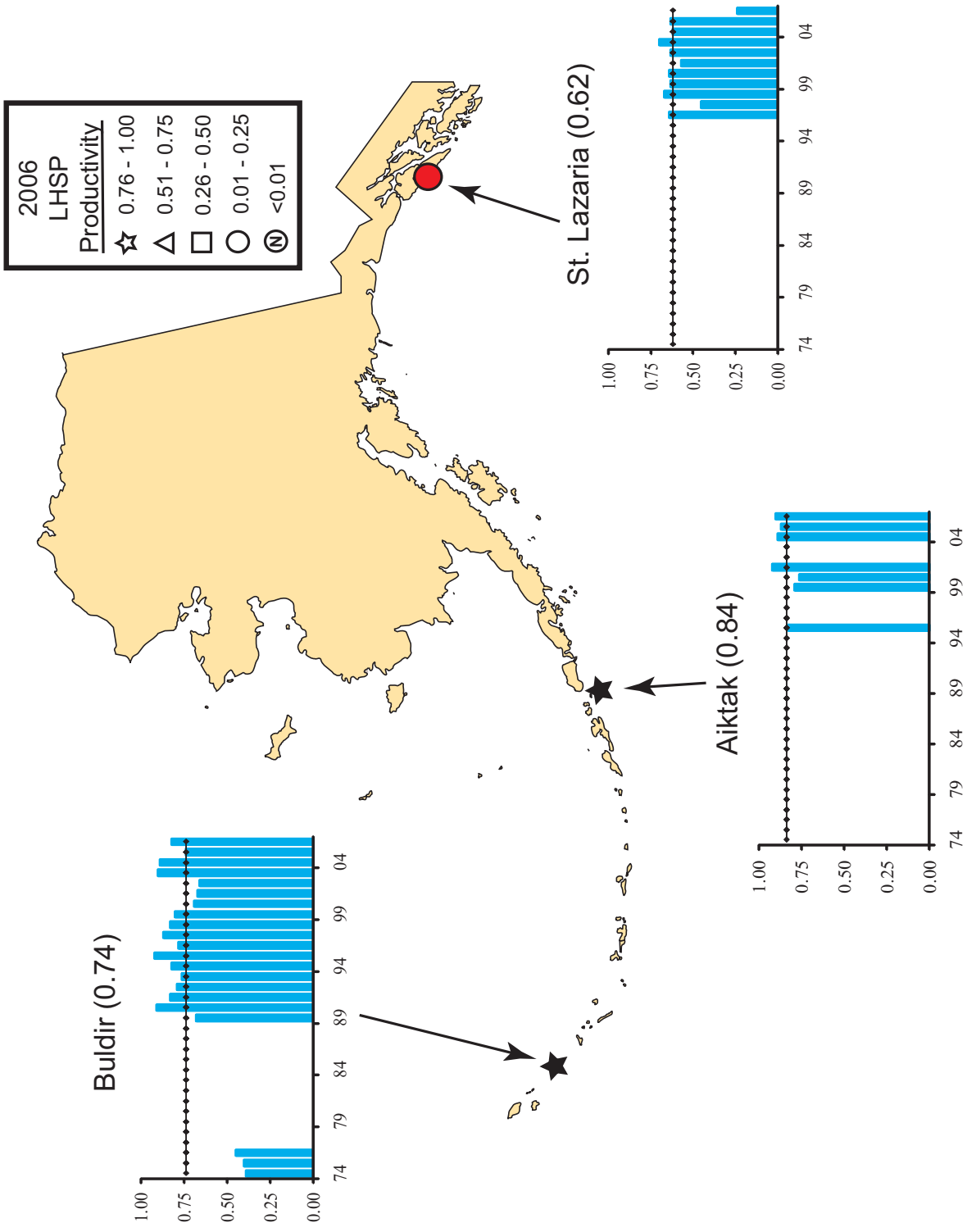


Figure 8. Productivity of Leach's storm-petrels (chicks fledged/egg) at Alaskan sites monitored in 2006. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is > 20% above site mean).

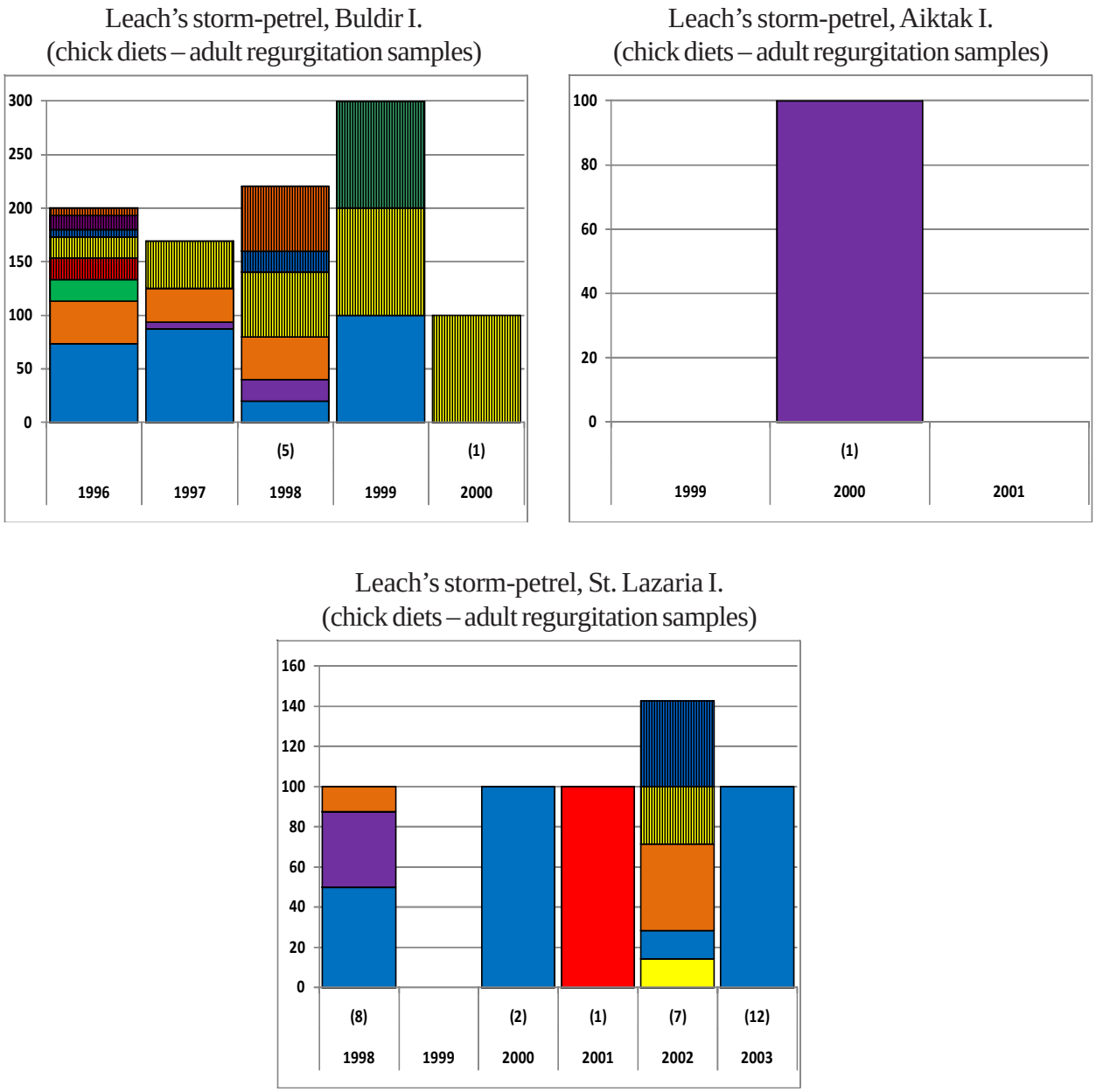


Figure 9. Diets of Leach's storm-petrels at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes, when available, are reported below each bar.

Red-faced cormorant (*Phalacrocorax urile*)

Breeding chronology.–Timing of hatching of red-faced cormorant eggs was late at St. Paul Island in 2006 (Table 6).

Table 6. Hatching chronology of red-faced cormorants at Alaskan sites monitored in 2006.

Site	Mean	Long-term Average	Reference
St. Paul I.	6 Jul (10)[a]	27 Jun[b] (17)[a]	Thomson and Spitler 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.

Productivity.–In 2006, productivity of red-faced cormorants was below average at St. Paul, St. George and Kasatochi islands, and above average at Buldir and Ulak islands. (Table 7, Fig. 10).

Table 7. Reproductive performance of red-faced cormorants at Alaskan sites monitored in 2006.

Site	Chicks Fledged/Nest	No. of Plots	Long-term Average	Reference
St. Paul I.	0.47	2 (57)[a]	1.24(22)[a]	Thomson and Spitler 2008
St. George I.	0.40	3 (35)	1.47 (9)	Pylant 2008
Buldir I.	3.00	N/A[b] (2)	1.23 (3)	Orben et al. 2006
Ulak I.	2.20[c]	N/A (29)	1.46 (9)	Buchheit and Ford 2008
Kasatochi I.	0.00	N/A (2)	1.01 (10)	Buchheit and Ford 2008

[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.

[c]Value obtained from one time visit to colony.

Populations.–Red-faced cormorants were differentiated from other cormorants at only one colony. We found a significant decline in the number of nests (-13.3% per annum) at Chiniak Bay (Fig. 11). We found no significant trends for cormorants (species combined) at any monitored site.

Diet.–No data.

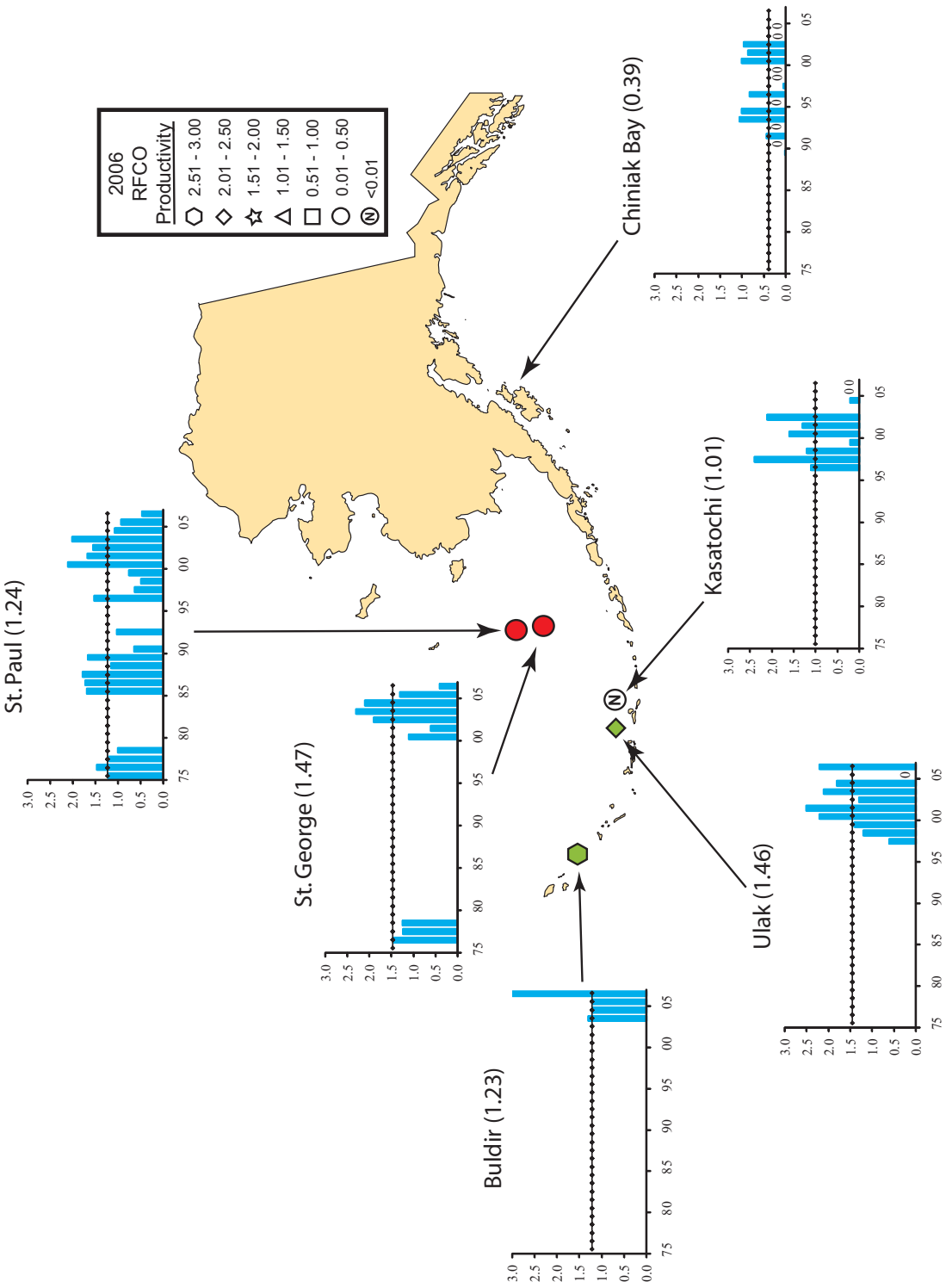


Figure 10. Productivity of red-faced cormorants (chicks fledged/nest) at Alaskan sites monitored in 2006. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is > 20% above site mean).

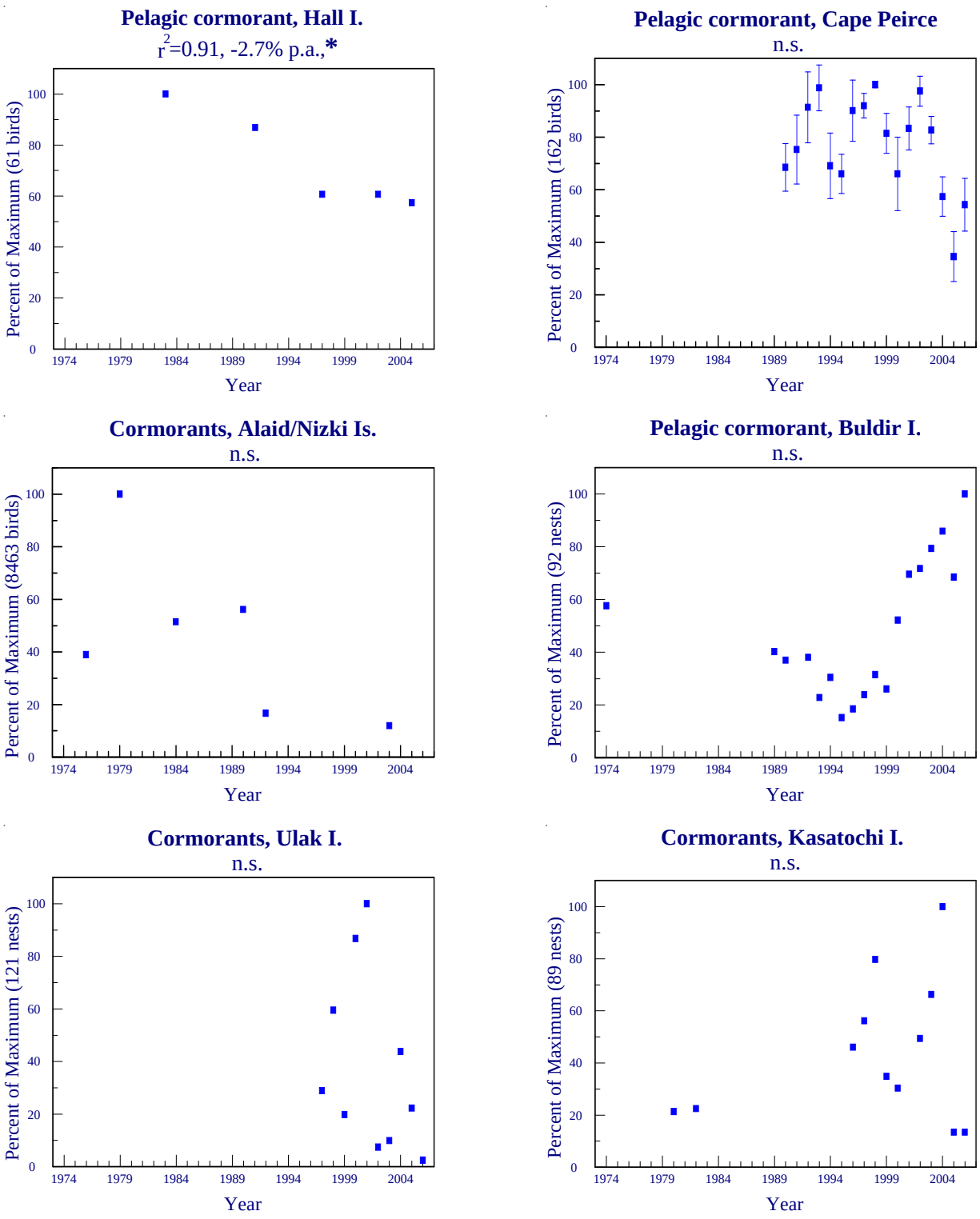


Figure 11. Trends in populations of cormorants at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Significance of trends indicated as: n.s. p>= 0.05 (not significant), * p<0.05, ** p<0.01, *** p<0.001. Rates of increase or decline are reported as percent change per annum (p.a.).

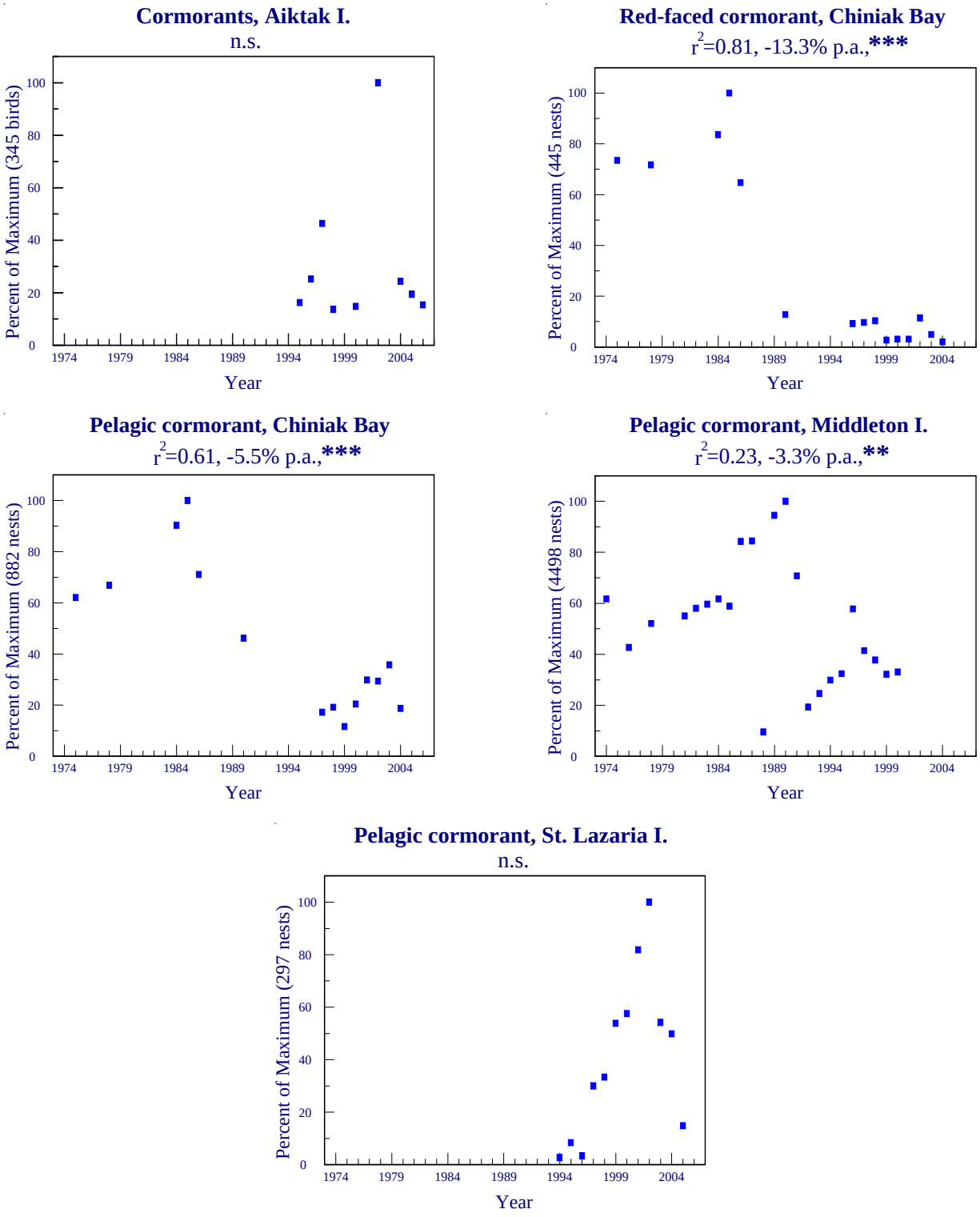


Figure 11 (continued). Trends in populations of cormorants at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Significance of trends indicated as: n.s. p>= 0.05 (not significant), * p<0.05, ** p<0.01, *** p<0.001. Rates of increase or decline are reported as percent change per annum (p.a.).

Pelagic cormorant (*Phalacrocorax pelagicus*)

Breeding chronology.–Hatching dates for pelagic cormorants were late at Cape Peirce in 2006 (Table 8).

Table 8. Hatching chronology of pelagic cormorants at Alaskan sites monitored in 2006.

Site	Median	Mean	Long-term Average	Reference
Cape Peirce	—	30 Jun (15)[a]	20 Jun[b] (14)[a]	R. MacDonald 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.–Pelagic cormorant productivity was below average at two monitored sites, average at two sites and above average at two sites in 2006 (Table 9, Fig. 12).

Table 9. Reproductive performance of pelagic cormorants at Alaskan sites monitored in 2006.

Site	Chicks Fledged/Nest	No. of Plots	Long-term Average	Reference
Cape Peirce	0.54	10 (44)[a]	1.29 (20)[a]	R. MacDonald Unpubl. Data
Round I.	1.73	4 (26)	1.44 (5)	Okonek and Snively 2006
Buldir I.	0.90	N/A[b] (92)	1.00 (16)	Orben et al. 2006
Ulak I.	2.00[c]	N/A (7)	1.61 (8)	Drummond 2006
Kasatochi I.	1.60	N/A (7)	0.99 (10)	Drummond 2006
St. Lazaria I.	0.46	N/A (42)	0.63 (12)	Slater and Byrd 2009

[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.
[c]Value obtained from one time visit to colony.

Populations.–Numbers of pelagic cormorants or nests (the index that has been used at some sites) have remained relatively stable at three monitored sites (Fig. 11). We found a significant negative trend for pelagic cormorants at Hall Island (-2.7% per annum), Chiniak Bay (-5.5% per annum) and Middleton Island (-3.3% per annum).

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

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.

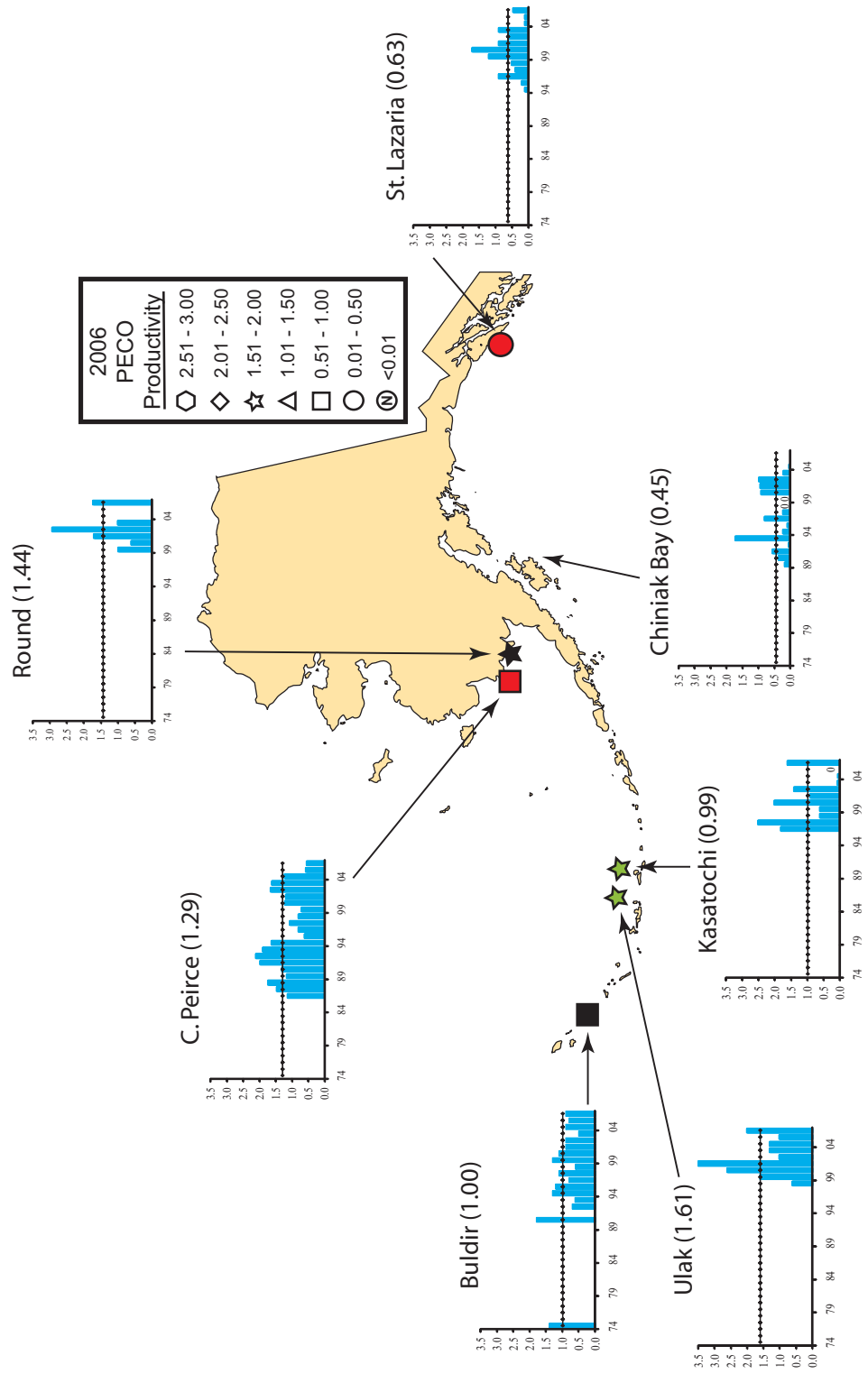


Figure 12. Productivity of pelagic cormorants (chicks fledged/nest) at Alaskan sites monitored in 2006. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is > 20% above site mean).

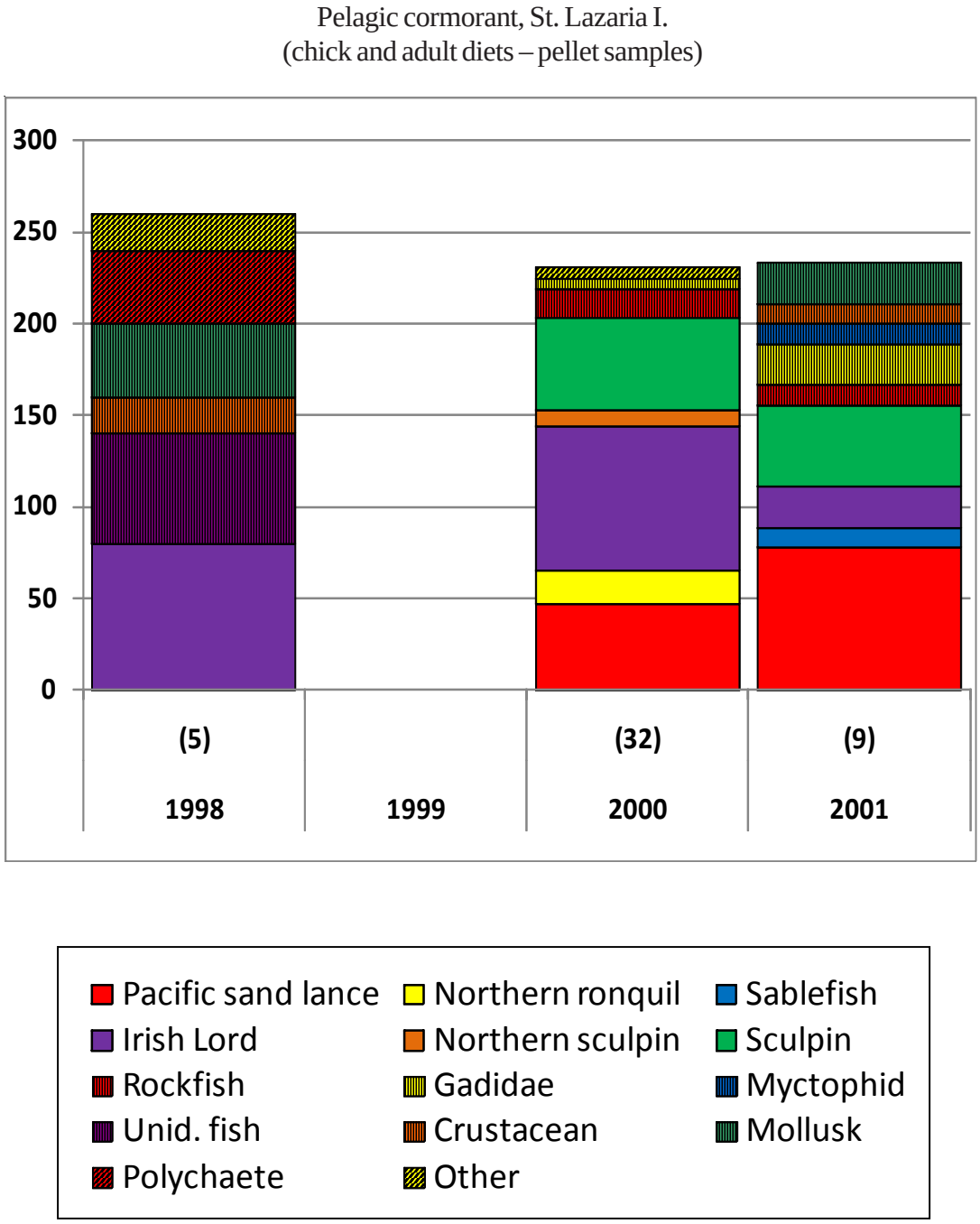


Figure 13. Diets of pelagic cormorants at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Glaucous-winged gull *(Larus glaucescens*)

Breeding chronology.–In 2006 glaucous-winged gull mean hatch date was later than average at Aiktak and St. Lazaria islands (Table 10, Fig. 14).

Table 10. Hatching chronology of glaucous-winged gulls at Alaskan sites monitored in 2006.

Site	Median	Mean	Long-term Average	Reference
Aiktak I.	25 Jul (10)[a]	27 Jul (10)	7 Jul[b] (11)[a]	Helm and Zeman 2006
St. Lazaria I.	31 Jul (9)	22 Jul (9)	2 Jul[b] (7)	Slater and Byrd 2009

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

Productivity.–Glaucous-winged gull hatching success in 2006 was above average at Buldir Island, average at Chowiet Island and below average at Aiktak and St. Lazaria islands (Table 11, Fig. 15).

Table 11. Reproductive performance of glaucous-winged gulls at Alaskan sites monitored in 2006.

Site	Hatching Success[a]	No. of Plots	Long-term Average	Reference
Buldir I.	0.45	N/A[b] (11)[c]	0.28 (14)[c]	Orben et al. 2006
Aiktak I.	0.25	N/A (72)	0.77 (11)	Helm and Zeman 2006
Chowiet I.	0.37	3 (193)	0.38 (5)	Helm and Zeman 2007
St. Lazaria I.	0.38	N/A	0.59 (10)	Slater and Byrd 2009

[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 significant negative trend at Buldir Island (-19.3% per annum) and an increase at Middleton and St. Lazaria islands (+8.9% and +11.4% per annum, respectively, Fig. 16). No trends were evident at other monitored colonies.

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 (Fig. 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.

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.

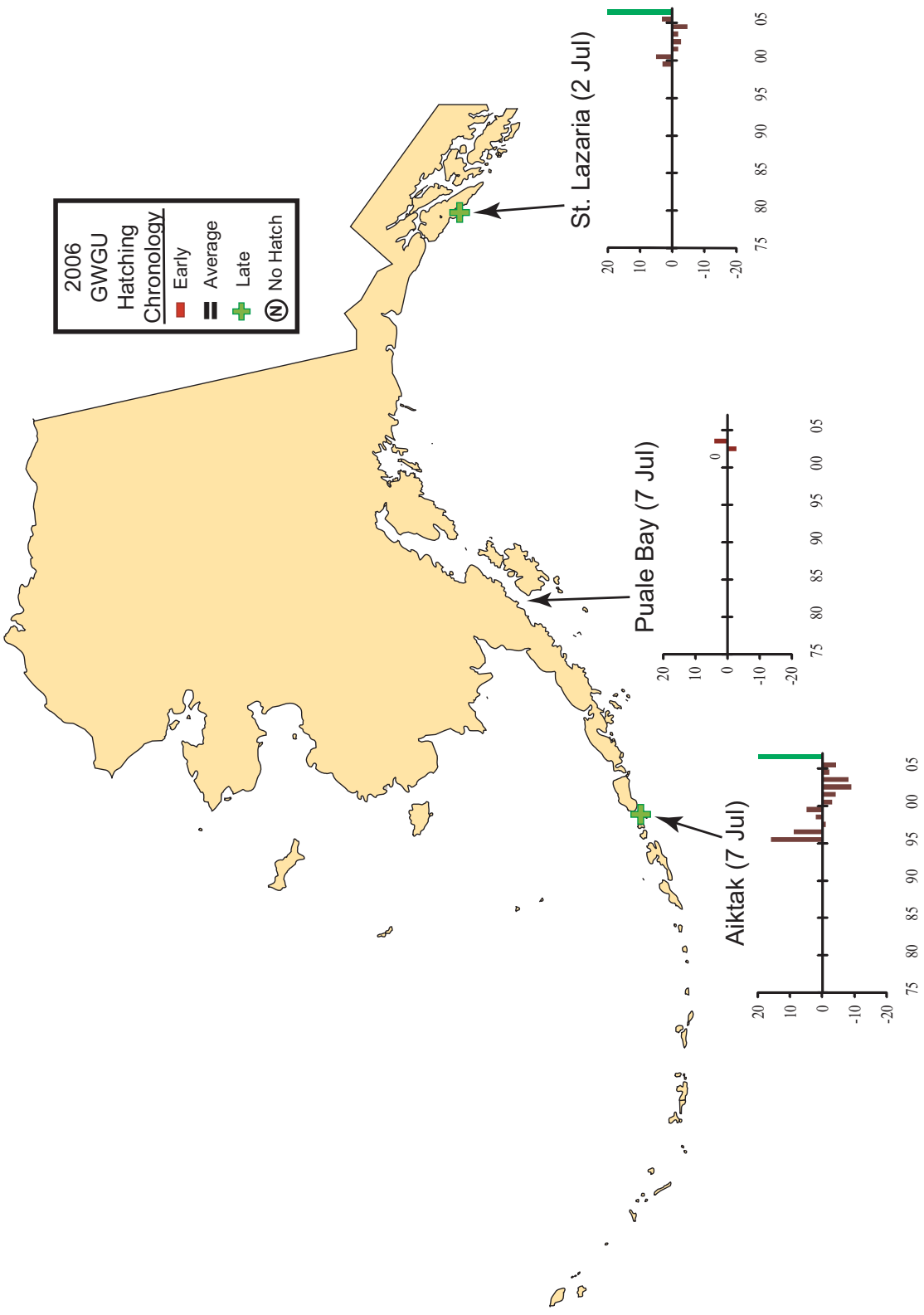


Figure 14. Hatching chronology of glaucous-winged gulls at Alaskan sites monitored in 2006. Graphs indicate the departure in days (if any), from the site mean (in parentheses; current year not included).

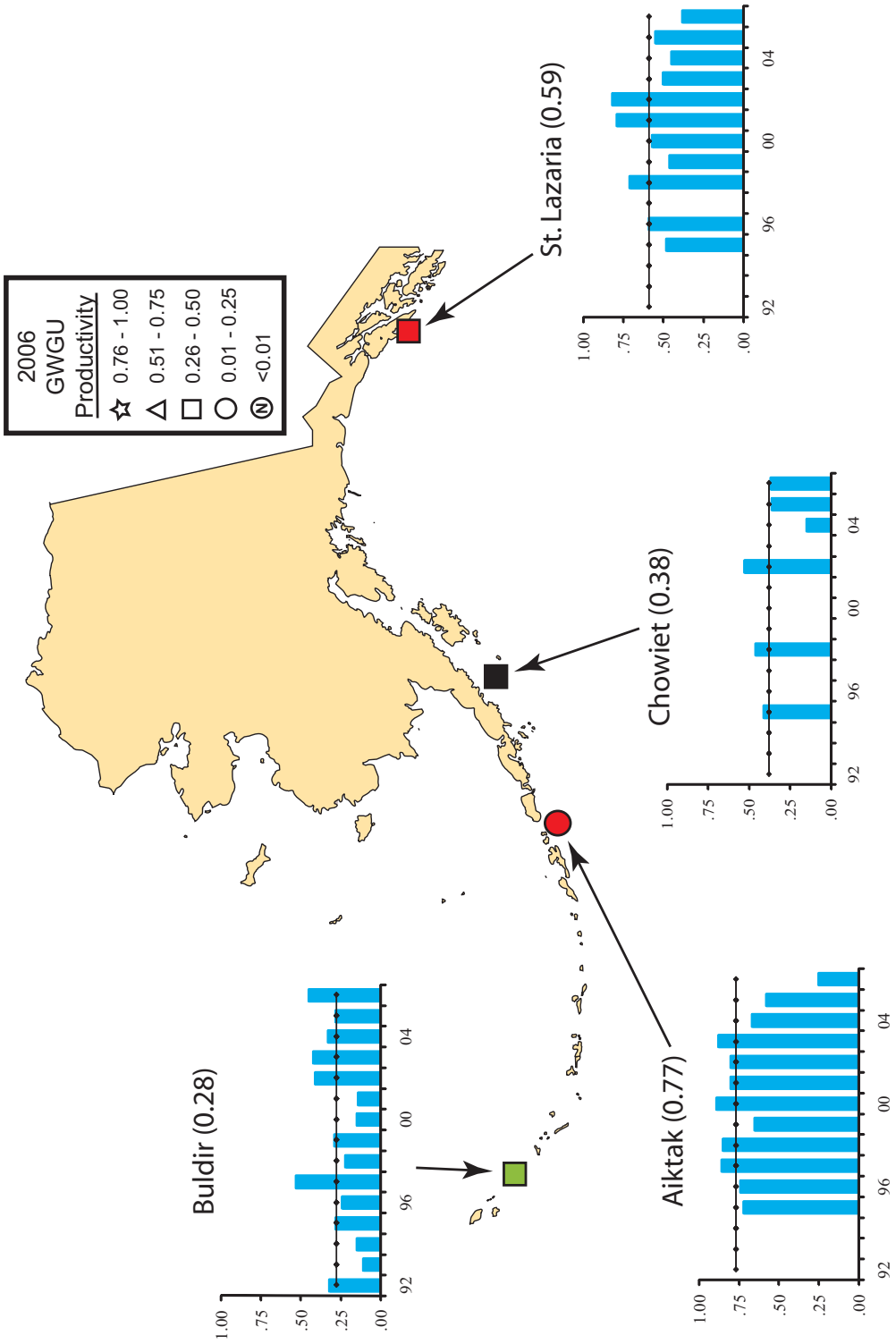


Figure 15. Productivity of glaucous-winged gulls (hatching success) at Alaskan sites monitored in 2006. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is > 20% above site mean).

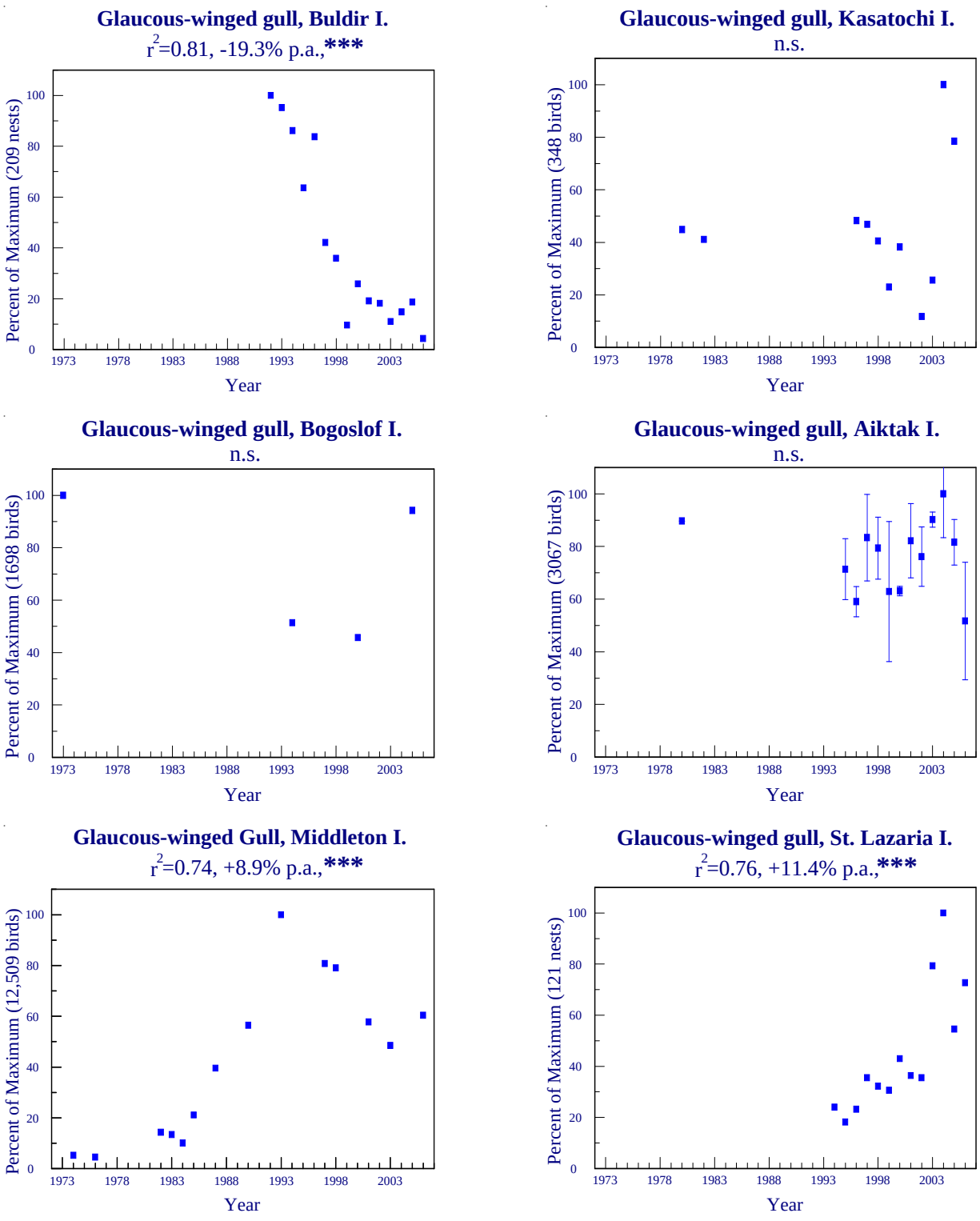


Figure 16. Trends in populations of glaucous-winged gulls at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Significance of trends indicated as: n.s. p>= 0.05 (not significant), * p<0.05, ** p<0.01, *** p<0.001. Rates of increase or decline are reported as percent change per annum (p.a.).

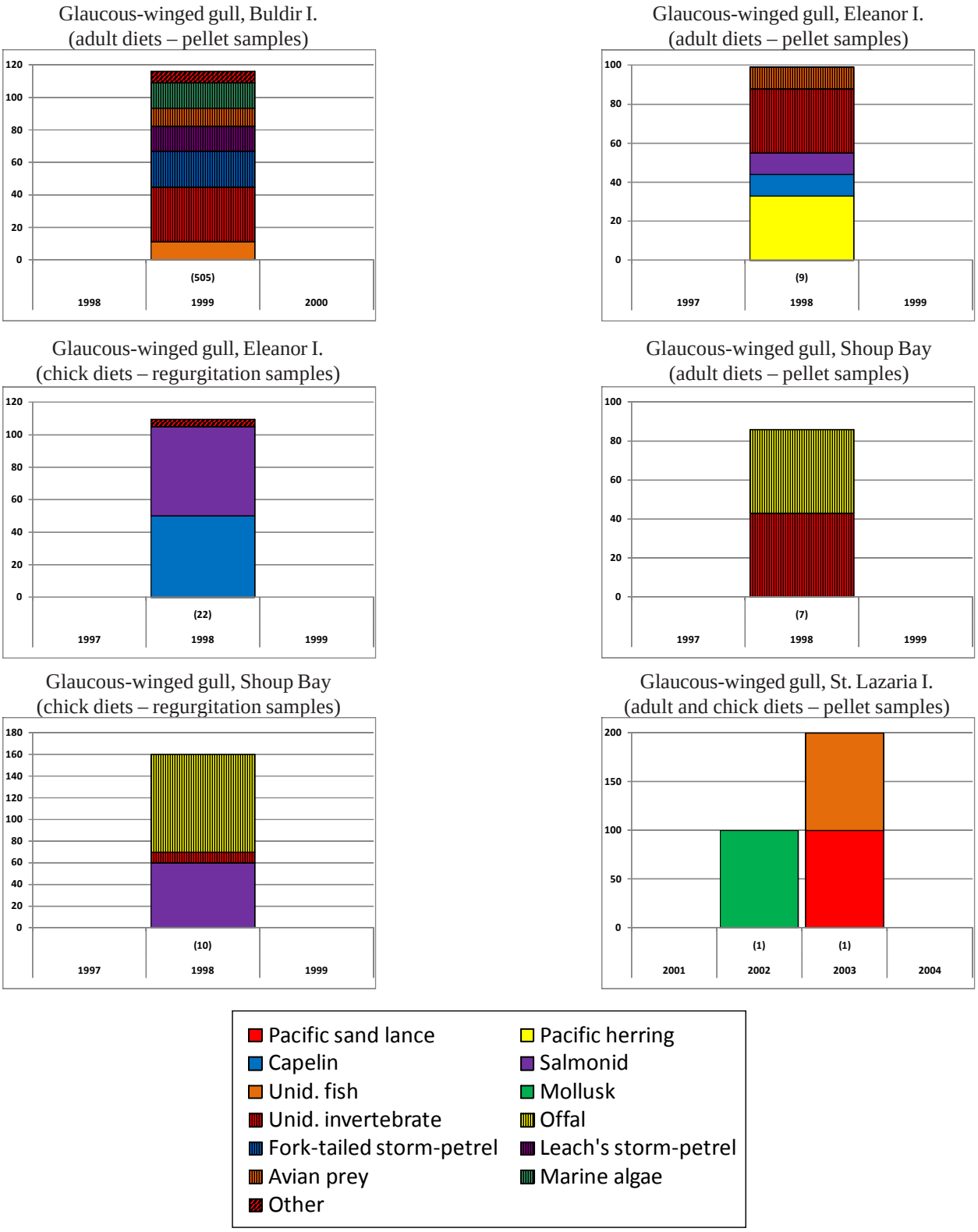


Figure 17. Diets of glaucous-winged gulls at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

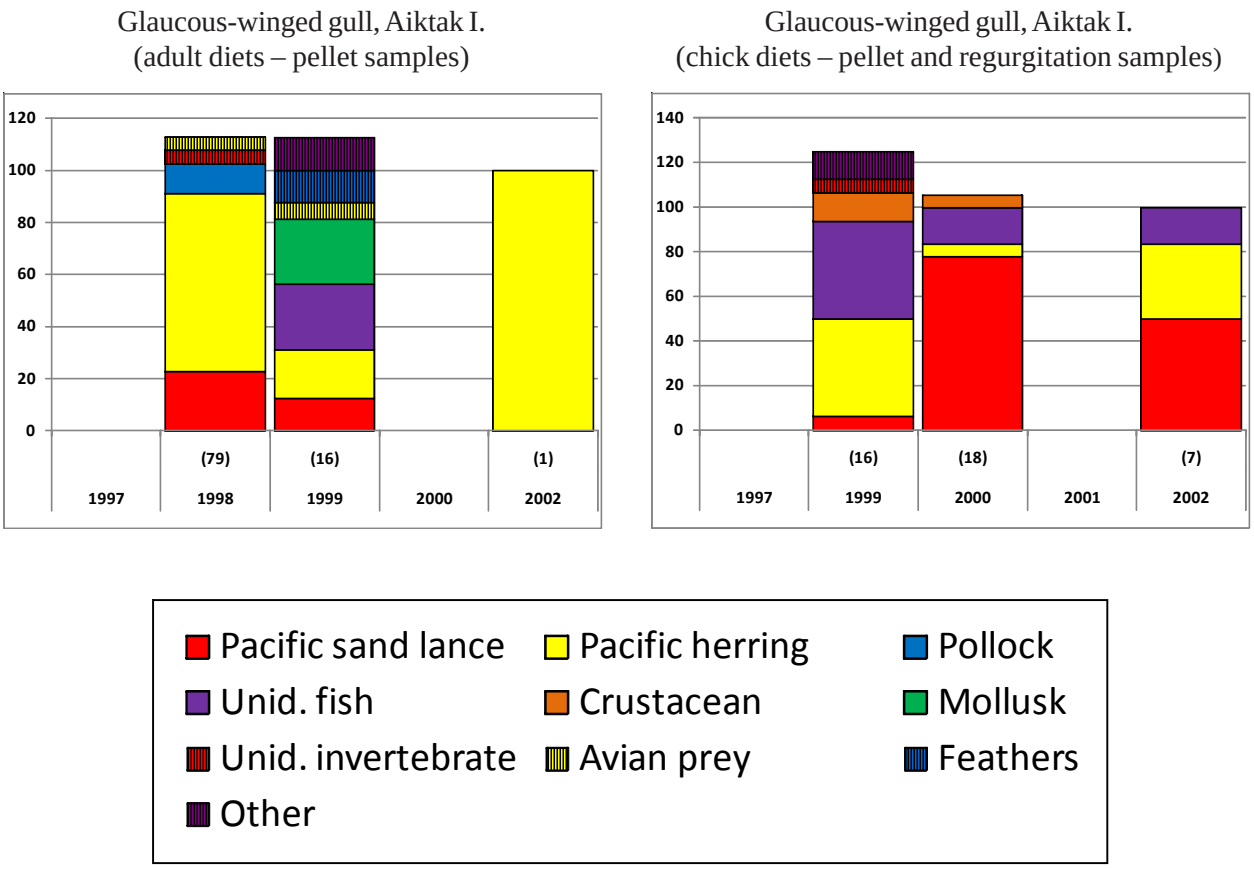


Figure 17 (continued). Diets of glaucous-winged gulls at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Black-legged kittiwake (*Rissa tridactyla*)

Breeding chronology.–In 2006, black-legged kittiwake hatching was early at St. Paul and St. George islands, and about average at all other monitored colonies (Table 12, Fig. 18).

Table 12. Hatching chronology of black-legged kittiwakes at Alaskan sites monitored in 2006.

Site	Median	Mean	Long-term Average	Reference
Bluff	—	24 Jul (82)[a]	24 Jul[b] (27)[a]	Murphy 2007
St. Paul I.	—	13 Jul (127)	20 Jul[b] (22)	Thomson and Spitler 2008
St. George I.	—	13 Jul (94)	19 Jul[b] (24)	Shannon 2008
Cape Peirce	—	11 Jul (3)	9 Jul[b] (17)	R. MacDonald Unpubl. Data
Buldir I.	7 Jul (88)	7 Jul (88)	6 Jul[b] (18)	Orben et al. 2006
Chowiet I.	17 Jul (200)	16 Jul (200)	18 Jul[b] (12)	Helm and Zeman 2007
E. Amatuli I.	13 Jul (209)	12 Jul (209)	12 Jul[b] (12)	A. Kettle, 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.–Productivity of black-legged kittiwakes was below average at six of the monitored colonies in 2006. Success was average at St. George Island and above average at four sites (Table 13, Fig. 19).

Populations.–Significantly negative population trends occurred at Hall (-3.6% per annum), St. Paul (-3.2%), Chowiet (-1.4%) and Middleton (-8.8%) islands, and at Cape Peirce (-7.6%, Fig. 20). Significant increases have occurred at Cape Lisburne (+2.7% per annum), Buldir Island (+5.2%) and Prince William Sound (+1.4%). No other monitored colonies exhibited significant population changes.

Diet.–In a small sample collected from Cape Lisburne, black-legged kittiwakes predominately ate small fish prey, including sand lance, gadids, and cod (Fig. 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 sandlance. Buldir Island samples included 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 Island diet samples included capelin and sand lance.

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.

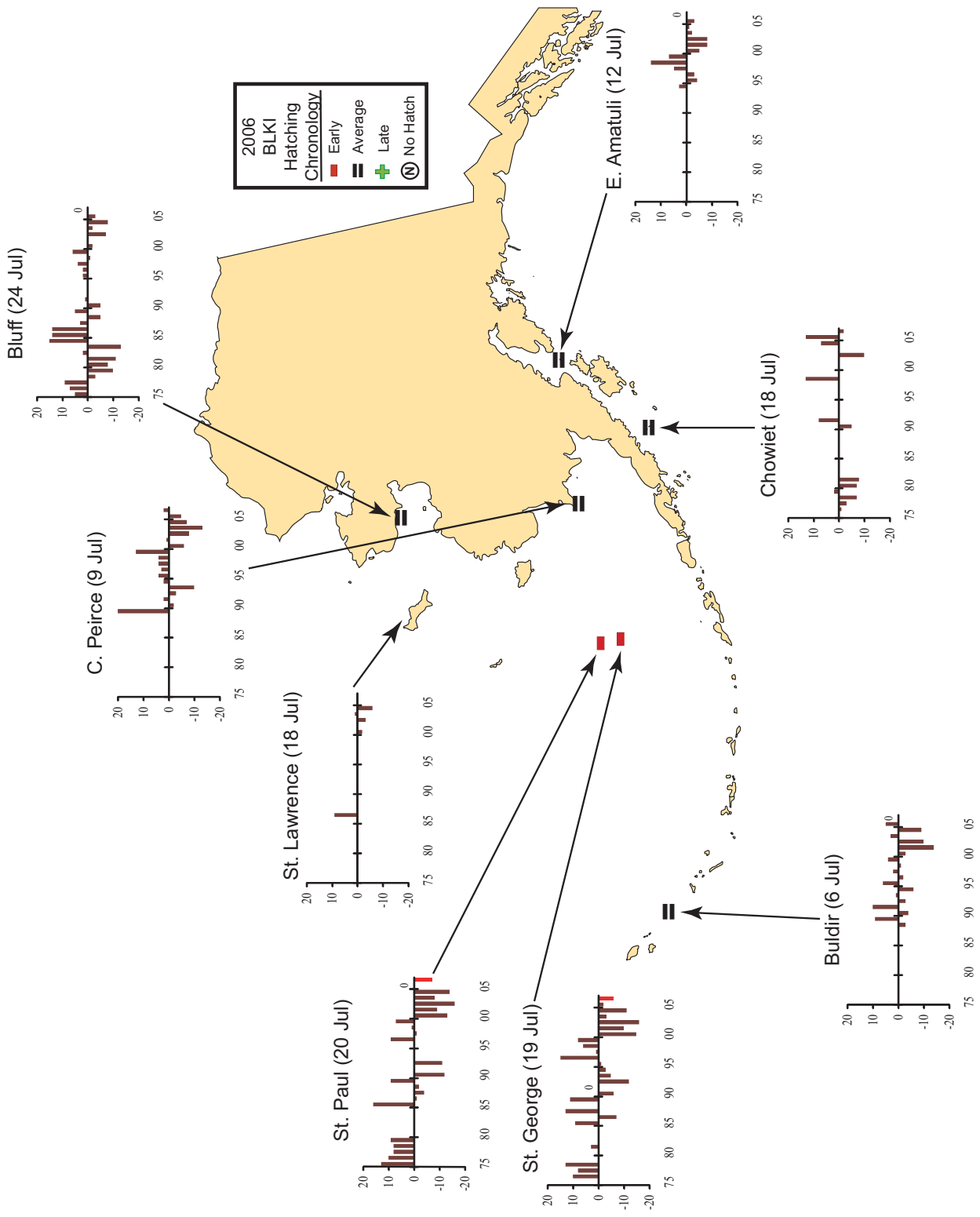


Figure 18. Hatching chronology of black-legged kittiwakes at Alaskan sites monitored in 2006. Graphs indicate the departure in days (if any), from the site mean (in parentheses; current year not included)

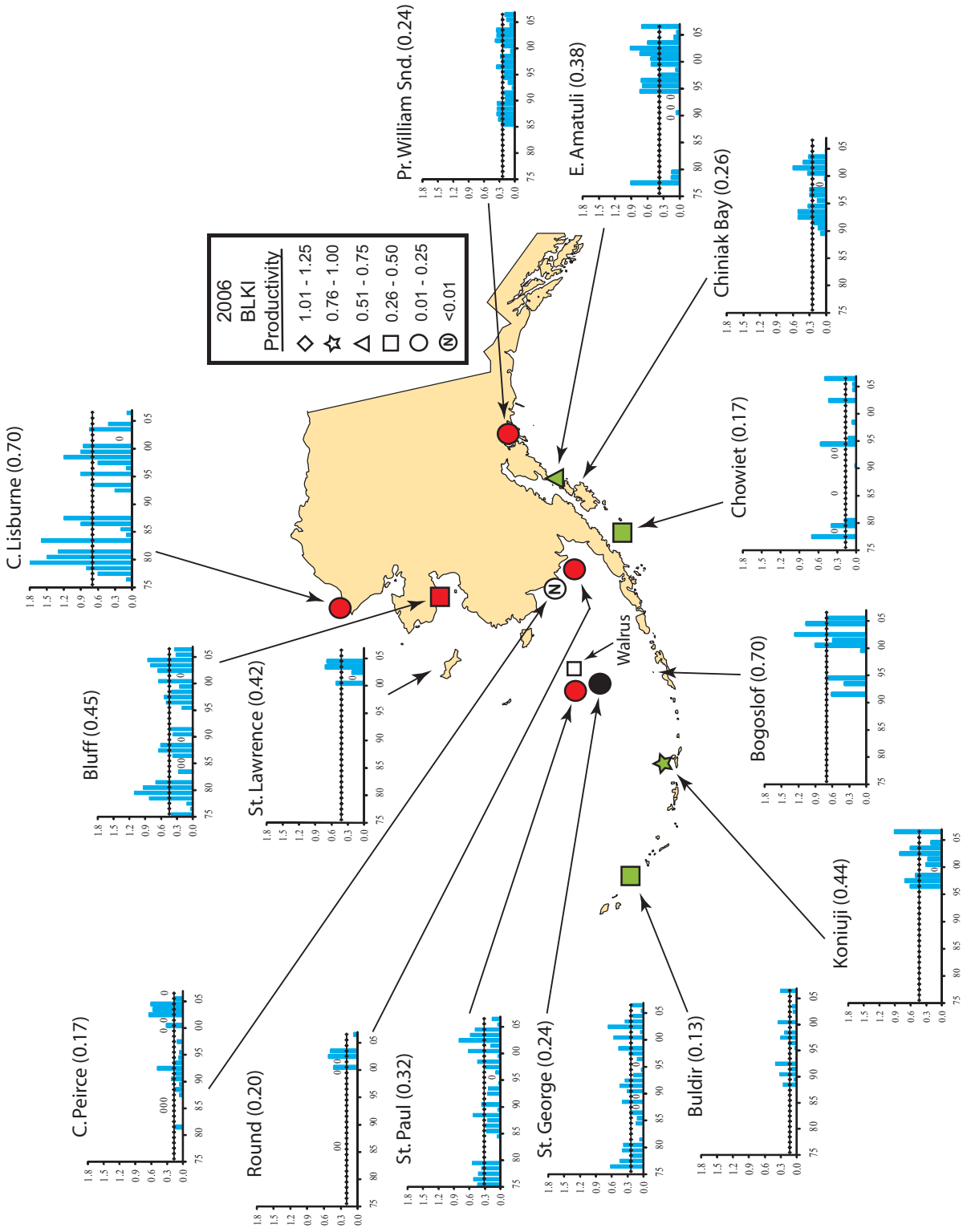


Figure 19. Productivity of black-legged kittiwakes (chicks fledged/nest) at Alaskan sites monitored in 2006. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is > 20% above site mean).

Table 13. Reproductive performance of black-legged kittiwakes at Alaskan sites monitored in 2006.

Site	Chicks Fledged[a]/Nest	No. of Plots	Long-term Average	Reference
C. Lisburne	0.09[b]	2 (156)[c]	0.70 (24)[c]	D. Roseneau Unpubl. Data
Bluff	0.34[b]	5 (131)	0.45 (27)	Murphy 2007
St. Paul I.	0.16	20 (479)	0.32 (26)	Thomson and Spitler 2008
Walrus I.	0.40	N/A[d] (40)	N/A	Thomson 2006
St. George I.	0.22	8 (255)	0.24 (30)	Pylant 2008
Cape Peirce	0.00	14 (211)	0.17 (23)	R. MacDonald Unpubl. Data
Round I.	0.06	4 (50)	0.20 (7)	Okonek and Snively 2006
Buldir I.	0.30	6 (227)	0.13 (18)	Orben et al. 2006
Koniuji I.	0.90[b]	5 (147)	0.44 (9)	Drummond 2006
Chowiet I.	0.49	12 (400)	0.17 (15)	Fairchild et al. 2007
E. Amatuli I.	0.70	11 (404)	0.38 (19)	A. Kettle Unpubl. Data
Pr. Will. Snd.	0.18[b]	N/A (24,163)	0.24 (21)	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.

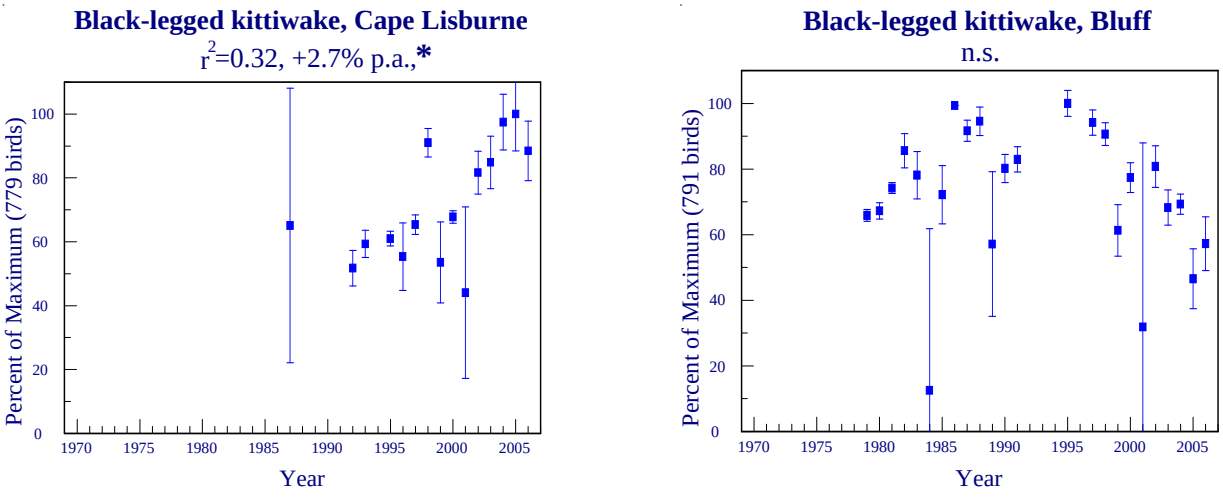


Figure 20. Trends in populations of black-legged kittiwakes at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Significance of trends indicated as: n.s. p>= 0.05 (not significant), * p<0.05, ** p<0.01, *** p<0.001. Rates of increase or decline are reported as percent change per annum (p.a.).

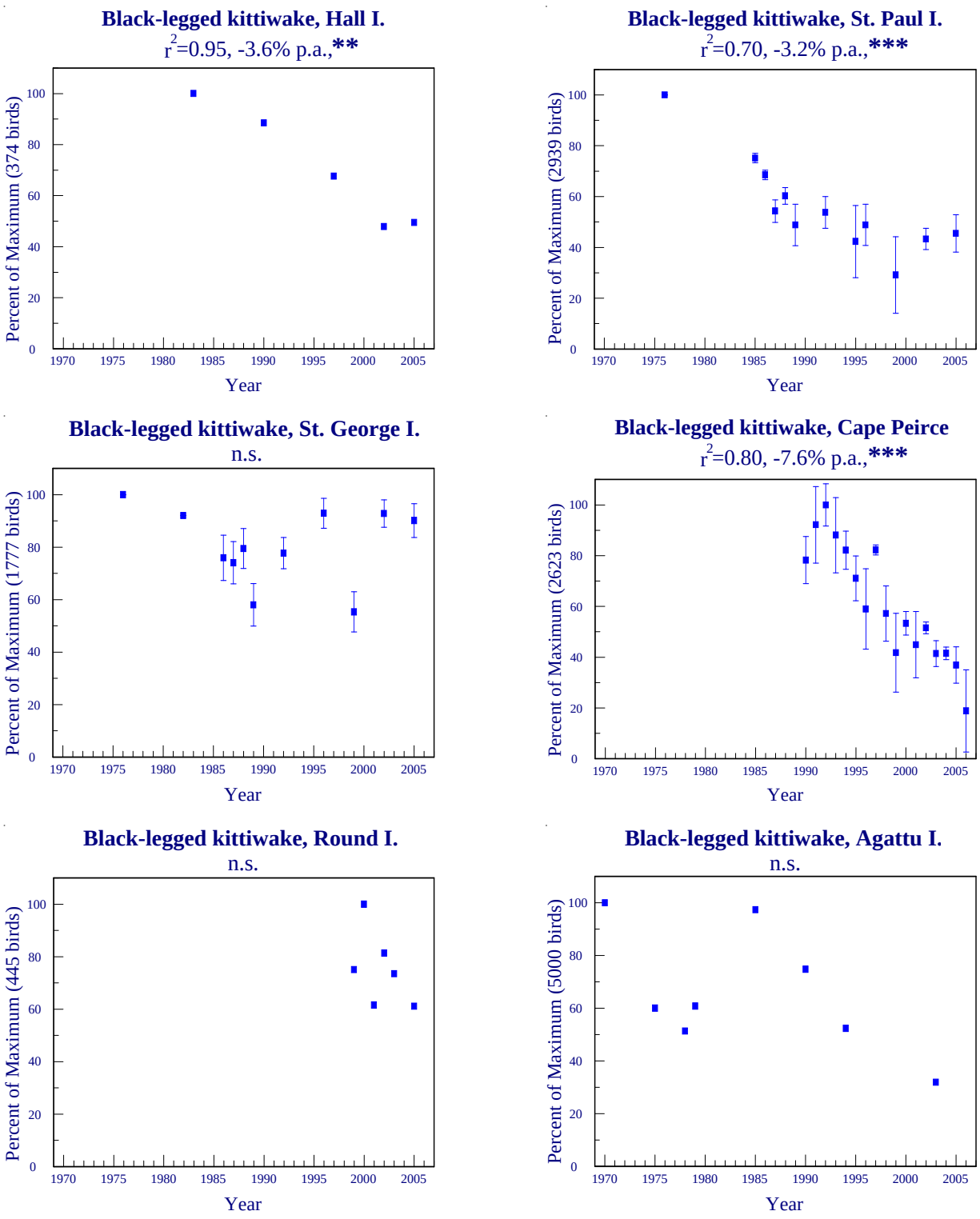


Figure 20 (continued). Trends in populations of black-legged kittiwakes at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Significance of trends indicated as: n.s. p>= 0.05 (not significant), * p<0.05, ** p<0.01, *** p<0.001. Rates of increase or decline are reported as percent change per annum (p.a.).

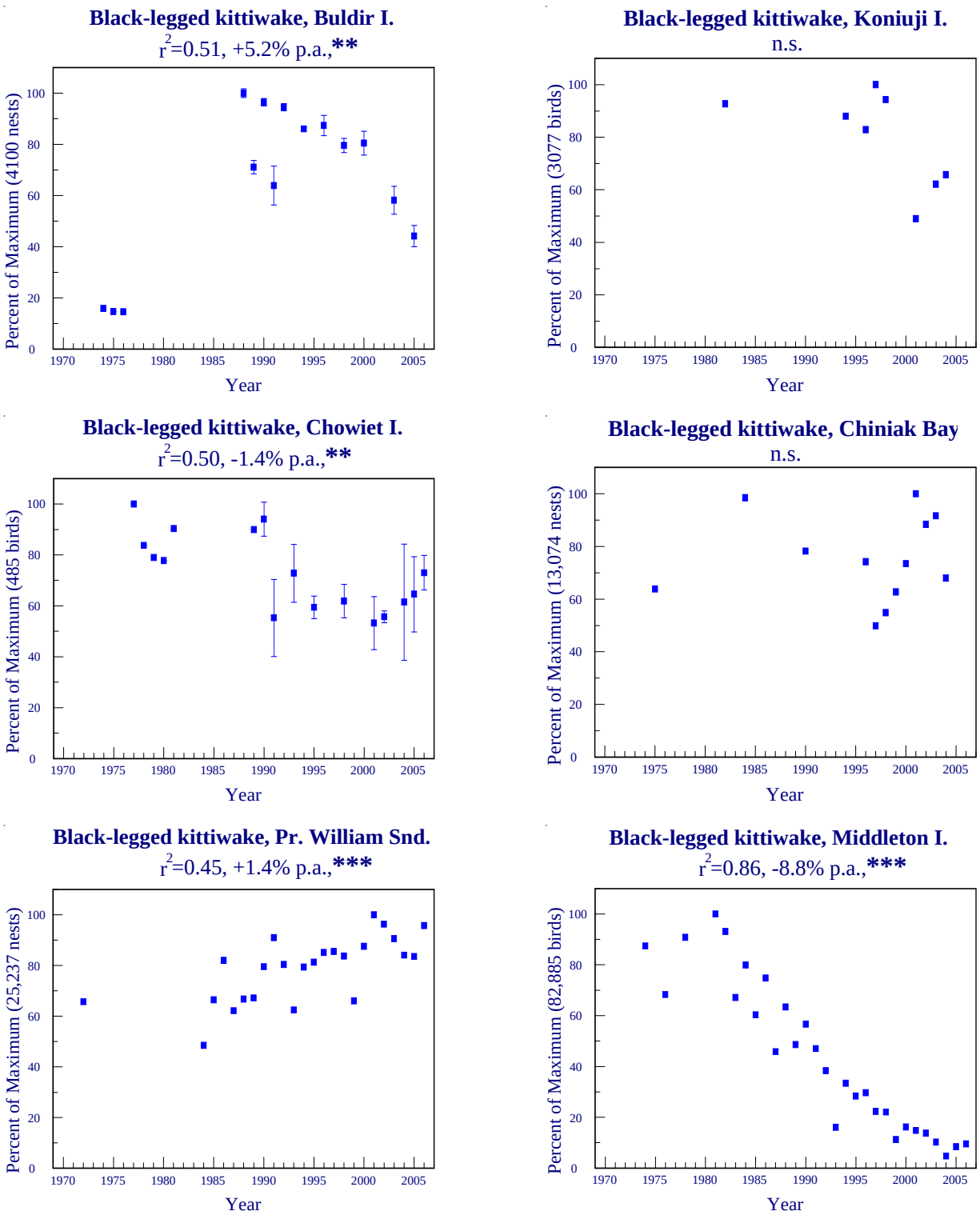


Figure 20 (continued). Trends in populations of black-legged kittiwakes at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Significance of trends indicated as: n.s. p>= 0.05 (not significant), * p<0.05, ** p<0.01, *** p<0.001. Rates of increase or decline are reported as percent change per annum (p.a.).

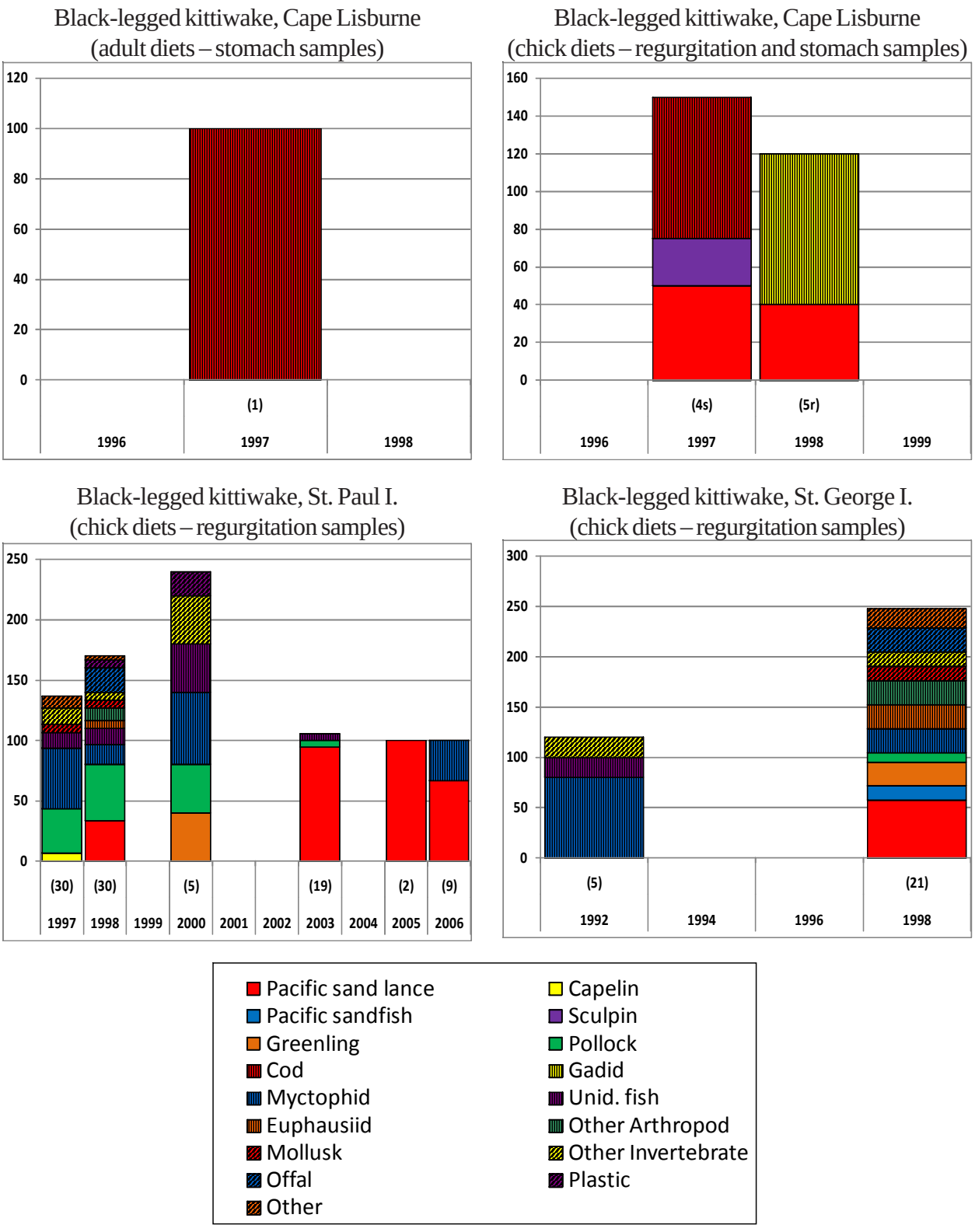


Figure 21. Diets of black-legged kittiwakes at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

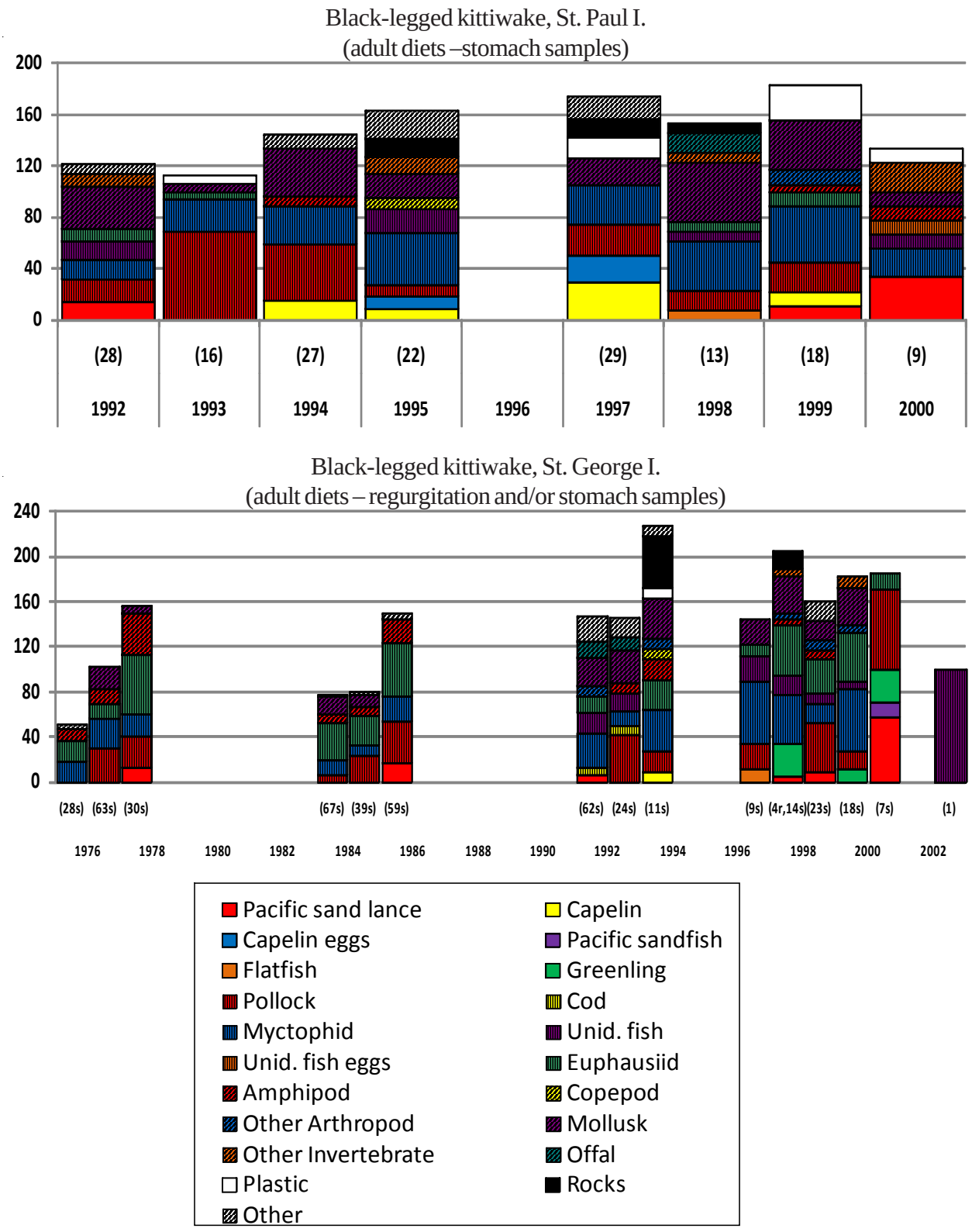
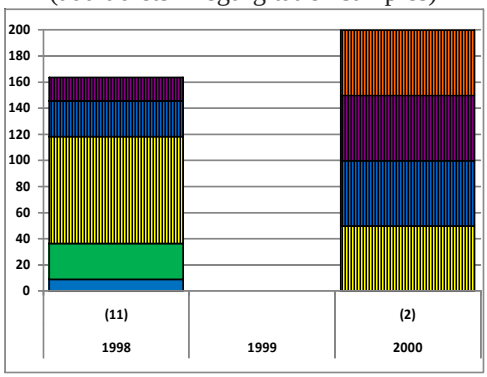
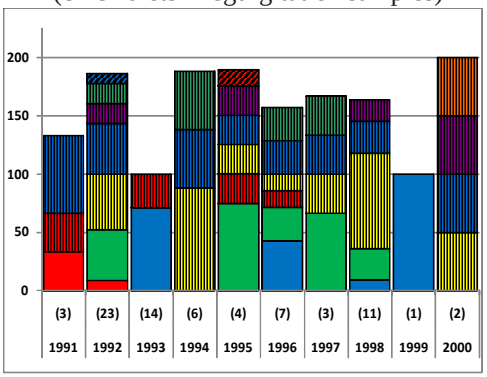


Figure 21 (continued). Diets of black-legged kittiwakes at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

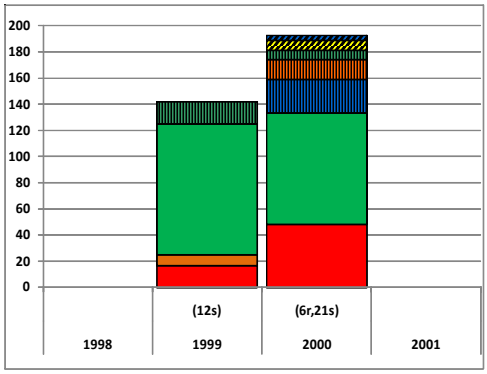
Black-legged kittiwake, Buldir I.
(adult diets – regurgitation samples)



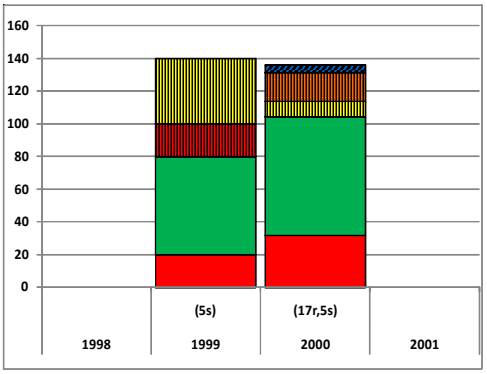
Black-legged kittiwake, Buldir I.
(chick diets – regurgitation samples)



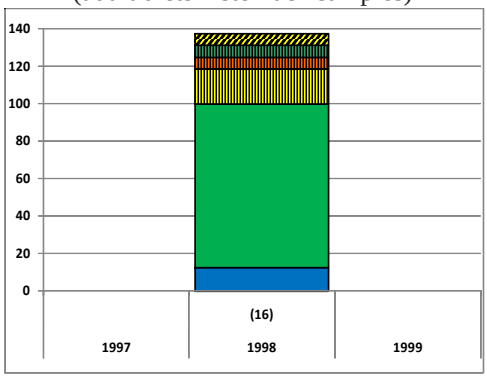
Black-legged kittiwake, Bogoslof I.
(adult diets – regurgitation and/or stomach samples)



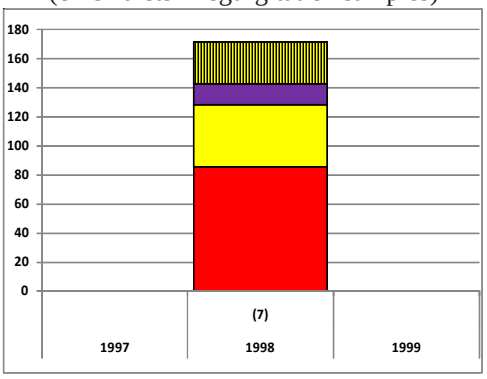
Black-legged kittiwake, Bogoslof I.
(chick diets – regurgitation and/or stomach samples)



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



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



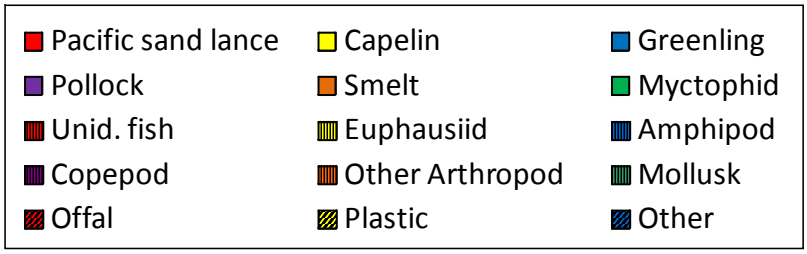


Figure 21 (continued). Diets of black-legged kittiwakes at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

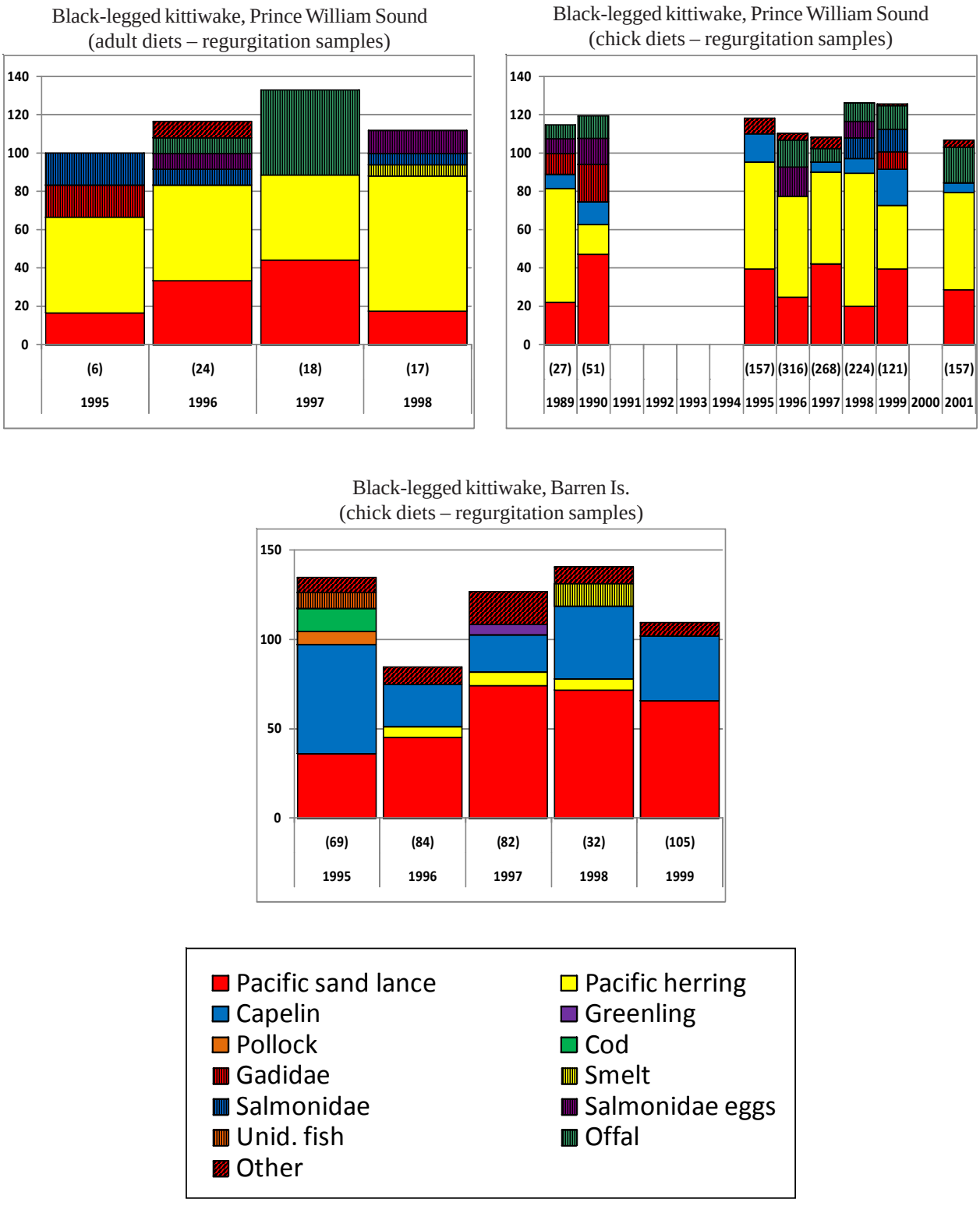


Figure 21 (continued). Diets of black-legged kittiwakes at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Red-legged kittiwake (*Rissa brevirostris*)

Breeding chronology.–Hatch date was early at St. George and St. Paul islands, and about average at Buldir Island in 2006 (Table 14, Fig. 22).

Table 14. Hatching chronology of red-legged kittiwakes at Alaskan sites monitored in 2006.

Site	Mean	Long-term Average	Reference
St. Paul I.	10 Jul (11)[a]	22 Jul[b] (21)[a]	Thomson and Spitler 2008
St. George I.	11 Jul (185)	18 Jul[b] (25)	Shannon 2008
Buldir I.	14 Jul (22)	12 Jul[b](17)	Orben et al. 2006

[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 2006, red-legged kittiwakes experienced below average productivity at St. Paul Island, about average success at St. George Island and above average productivity at Buldir Island (Table 15, Fig. 23).

Table 15. Reproductive performance of red-legged kittiwakes at Alaskan sites monitored in 2006.

Site	Chicks Fledged[a]/Nest	No. of Plots	Long-term Average	Reference
St. Paul I.	0.14	2 (35)[b]	0.24 (26)[b]	Thomson and Spitler 2008
St. George I.	0.23	15 (185)	0.25 (30)	Shannon 2008
Buldir I.	0.24	N/A[c] (55)	0.15 (18)	Orben et al. 2006

[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 significantly at St. Paul Island (-3.3% per annum). This species exhibited a positive population trend at Buldir Island (+2.7% per annum), and no trend at St. George Island (Fig. 24).

Diet.–Diet samples from Bogoslof Island were dominated by myctophids and small invertebrates (Fig. 25). Diets collected from St. Paul Island contained predominately pollock and squid. Red-legged kittiwakes from St. George and Buldir Islands ate predominately myctophids with lesser amounts of other small fish and invertebrates.

Only prey that occurred in 5% or more of the 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.

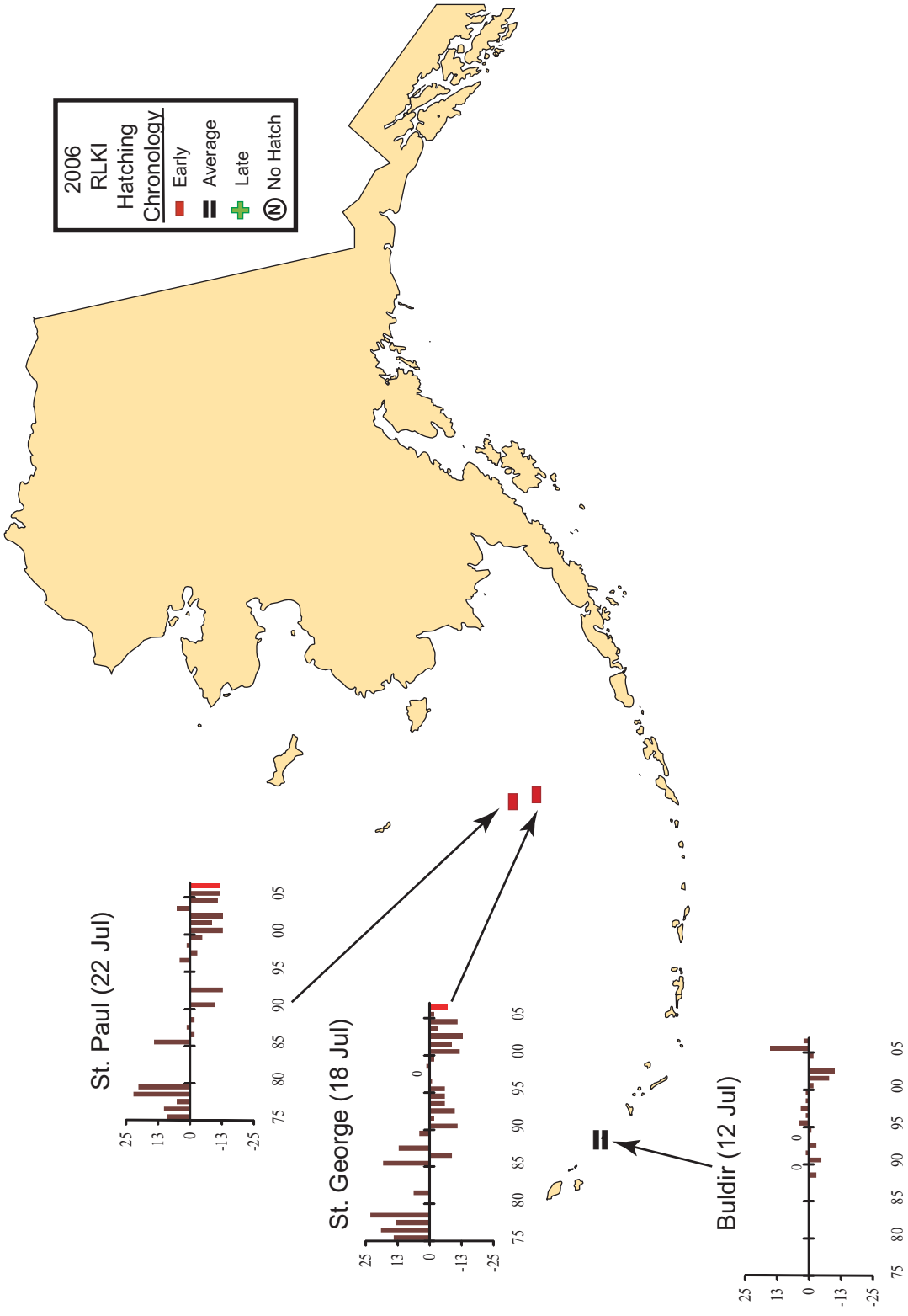


Figure 22. Hatching chronology of red-legged kittiwakes at Alaskan sites monitored in 2006. Graphs indicate the departure in days (if any), from the site mean (in parentheses; current year not included).

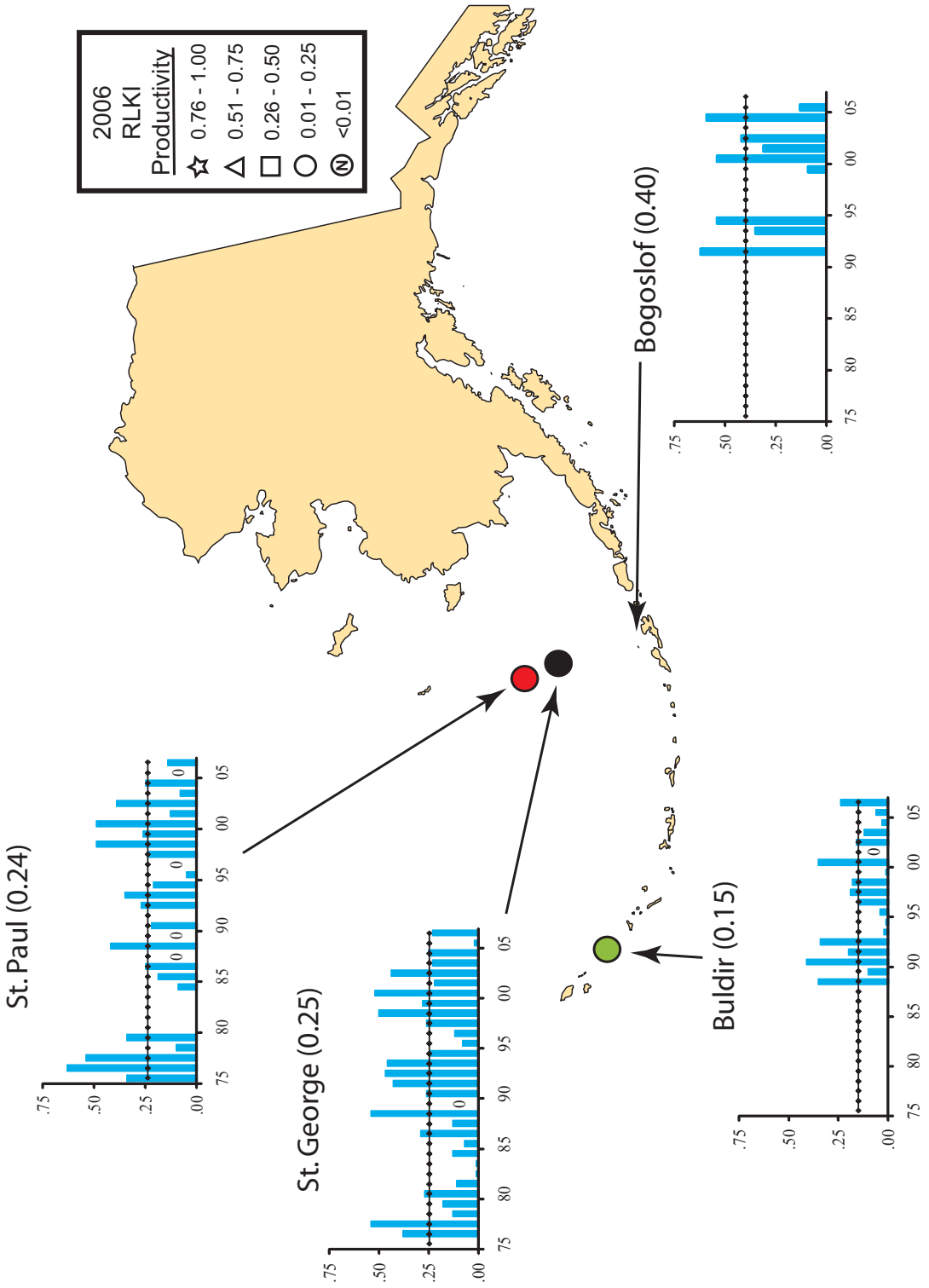


Figure 23. Productivity of red-legged kittiwakes (chicks fledged/nest) at Alaskan sites monitored in 2006. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is > 20% above site mean).

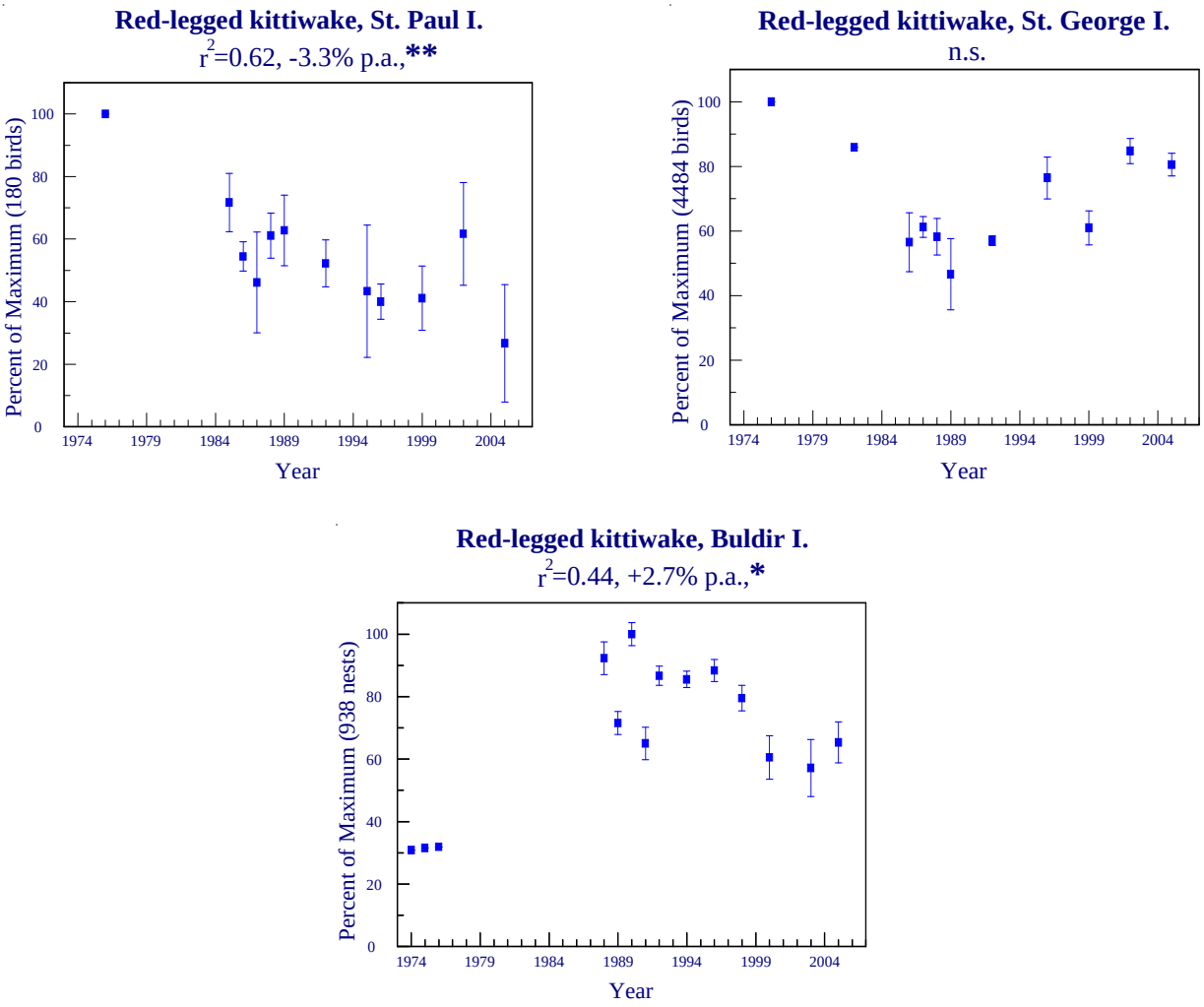


Figure 24. Trends in populations of red-legged kittiwakes at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Significance of trends indicated as: n.s. p>= 0.05 (not significant), * p<0.05, ** p<0.01, *** p<0.001. Rates of increase or decline are reported as percent change per annum (p.a.).

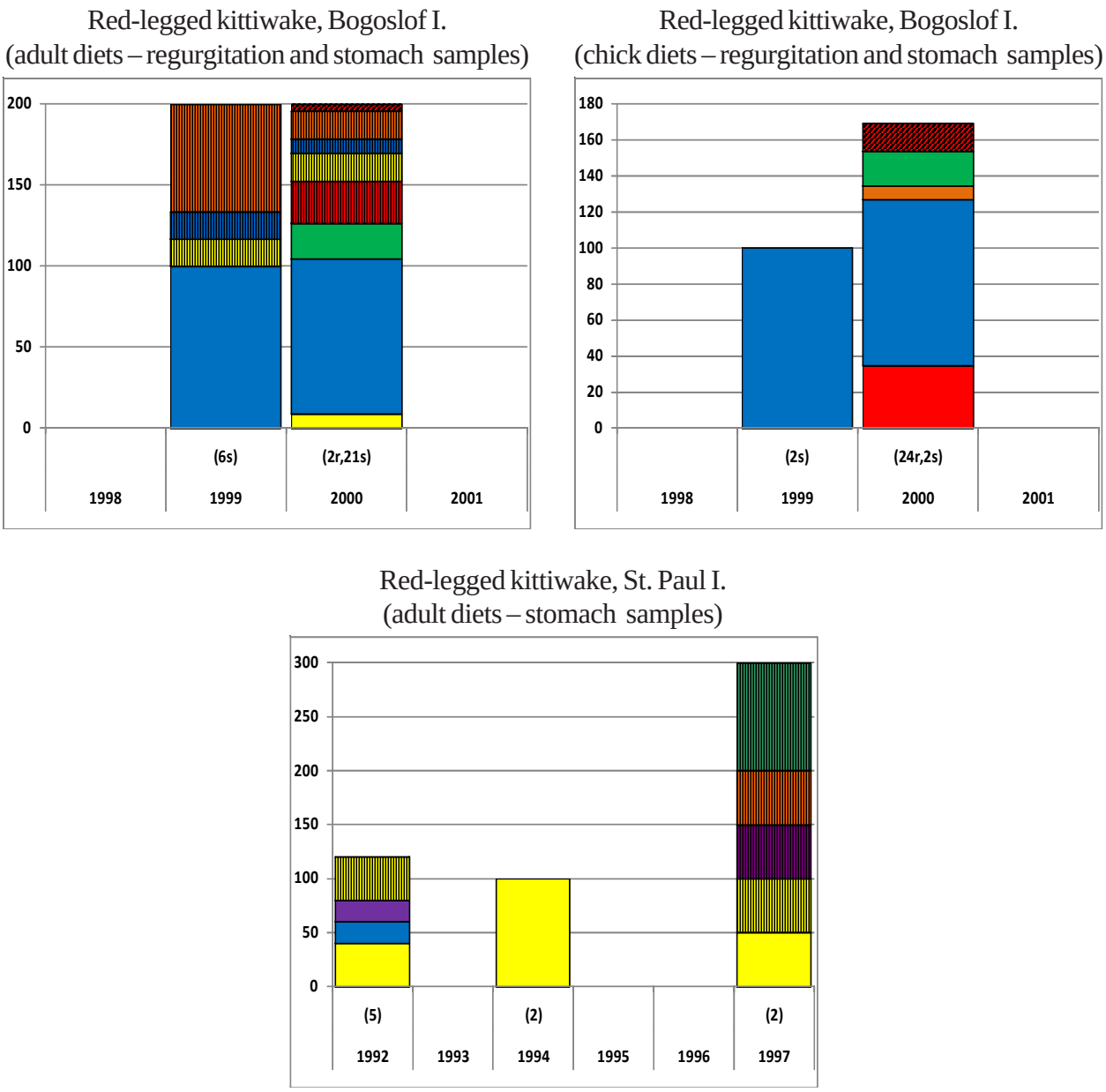


Figure 25. Diets of red-legged kittiwakes at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

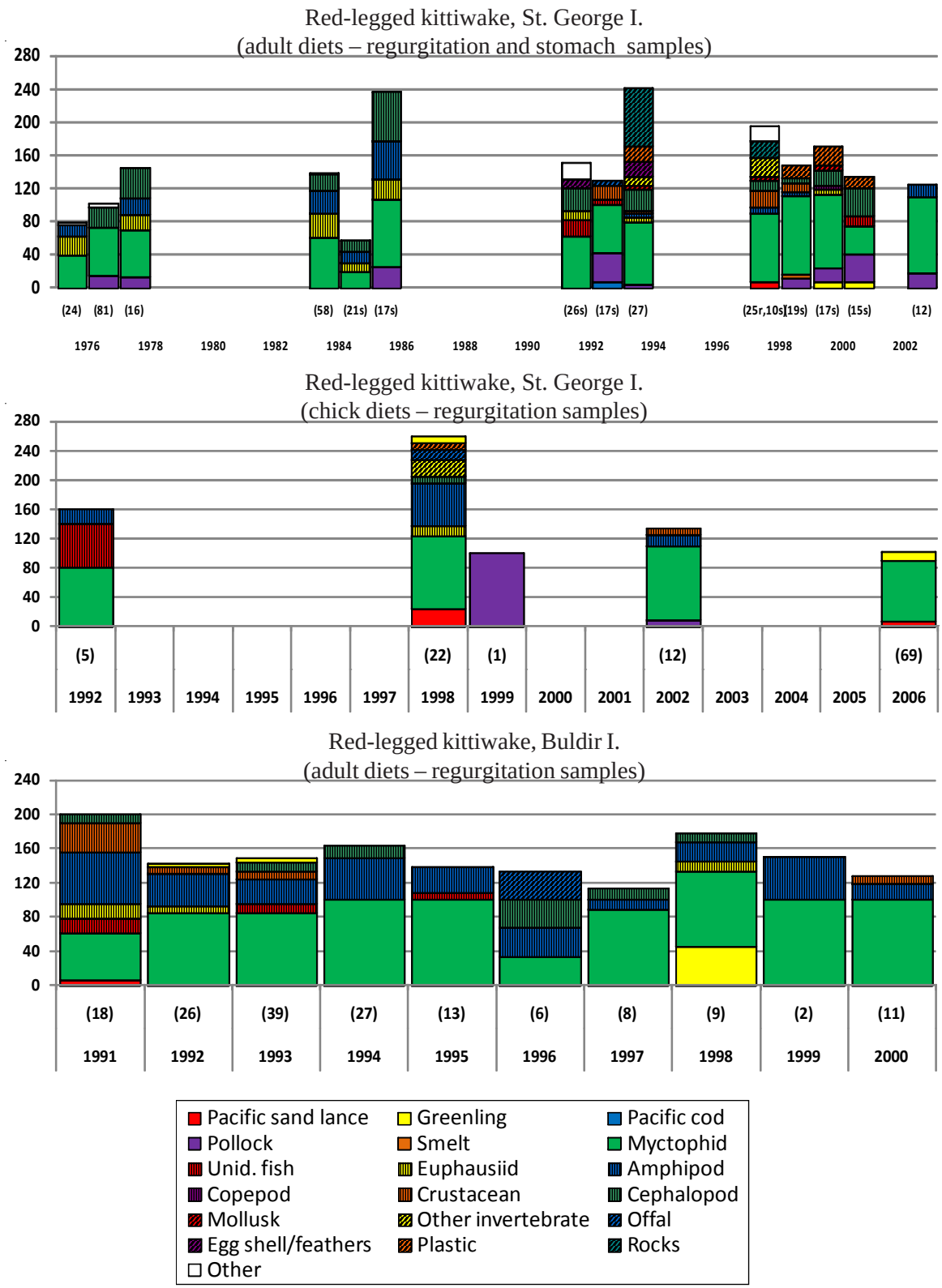


Figure 25 (continued). Diets of red-legged kittiwakes at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Common murre (*Uria aalge*)

Breeding chronology.–Timing of common murre nesting events in 2006 was later than average at St. Paul, St. George, East Amatuli, and St. Lazaria islands, and about average at all other monitored sites (Table 16, Fig. 26).

Table 16. Hatching chronology of common murres at Alaskan sites monitored in 2006.

Site	Median	Mean	Long-term Average	Reference
Bluff	23 Jul (N/A[a])[b]	—	26 Jul[c] (29)[b]	Murphy 2007
St. Paul I.	—	11 Aug (31)	6 Aug[d] (21)	Thomson and Spitler 2008
St. George I.	—	12 Aug (39)	5 Aug[d] (22)	Shannon 2008
Cape Peirce	—	20 Jul (58)	21 Jul[d] (17)	R. MacDonald Unpubl. Data
Buldir I.	12 Jul (5)	15 Jul (5)	17 Jul[d] (7)	Orben et al. 2006
Chowiet I.	22 Jul (122)	24 Jul (122)	22 Jul[d] (11)	Helm and Zeman 2007
E. Amatuli I.	16 Aug (189)	14 Aug (189)	8 Aug[d] (13)	A. Kettle Unpubl. Data
St. Lazaria I.	—	19 Aug (35)	12 Aug[d] (12)	Slater and Byrd 2009

[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 medians.

[d]Mean of annual means.

Productivity.–Common murre productivity was average at six monitored sites, below average at two sites, and average at one site in 2006 (Table 17, Fig. 27).

Populations.–At sites where counts of murres are made from the water, it is difficult to accurately assign every individual to a species. As a result, common and thick-billed murres often are combined at these colonies for population trend analysis. We found significant negative trends in common murre numbers at St. Paul Island and Cape Peirce (-3.2% and -4.0% per annum, respectively, Fig. 28). No trends were discernible for this species at any other monitored site. Where murres were not identified to species, we found significant negative trends at Aiktak, Middleton and St. Lazaria islands (-6.3%, -5.8% and-2.4% per annum, respectively). Significant positive trends were evident for murres at Cape Lisburne (+3.5% per annum), and Agattu, Koniuji and Chowiet islands (+2.7%, +10.6% and +1.1% per annum, respectively). No trends were found for unidentified murres at other monitored colonies.

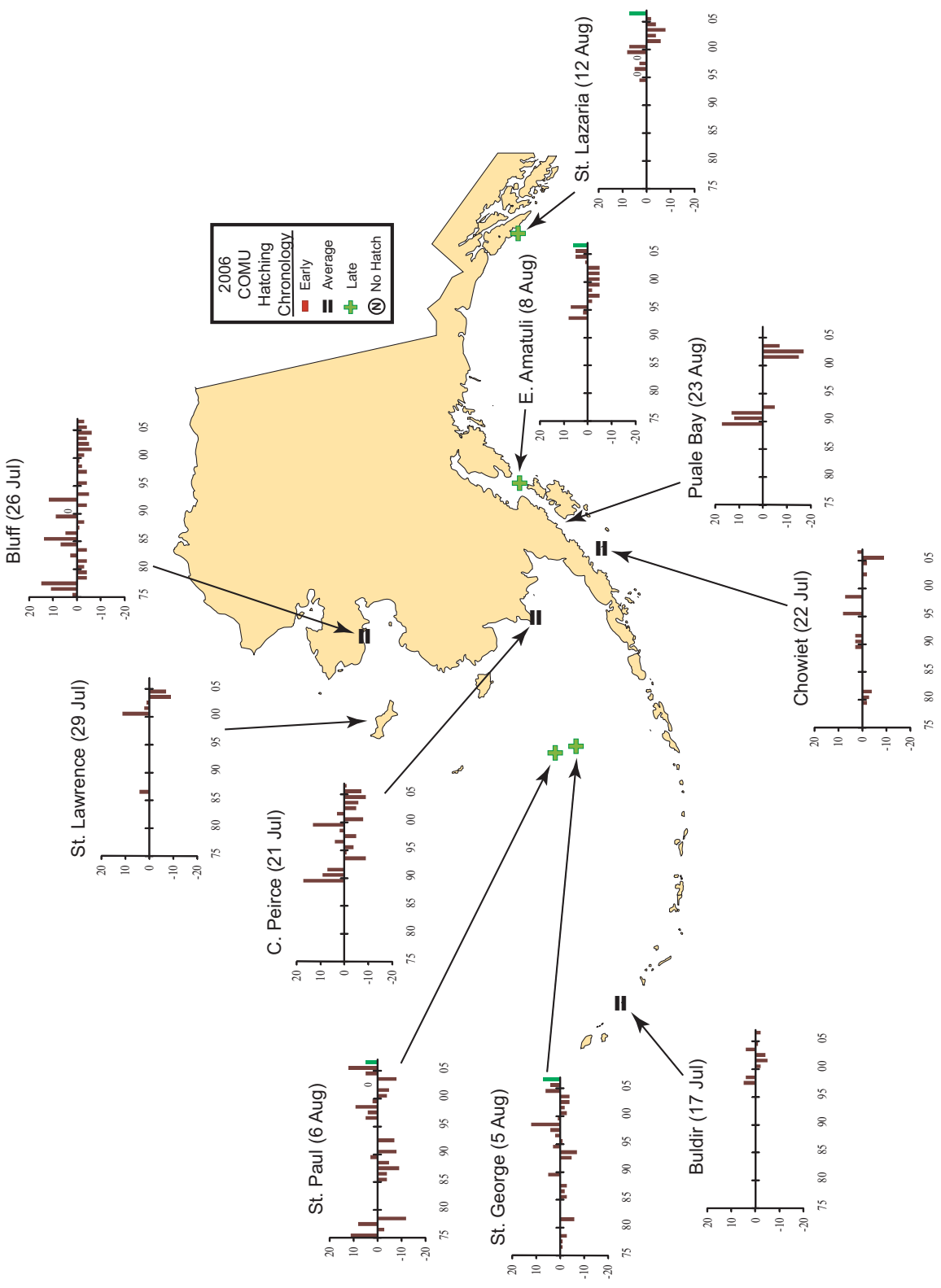


Figure 26. Hatching chronology of common murres at Alaskan sites monitored in 2006. Graphs indicate the departure in days (if any), from the site mean (in parentheses; current year not included).

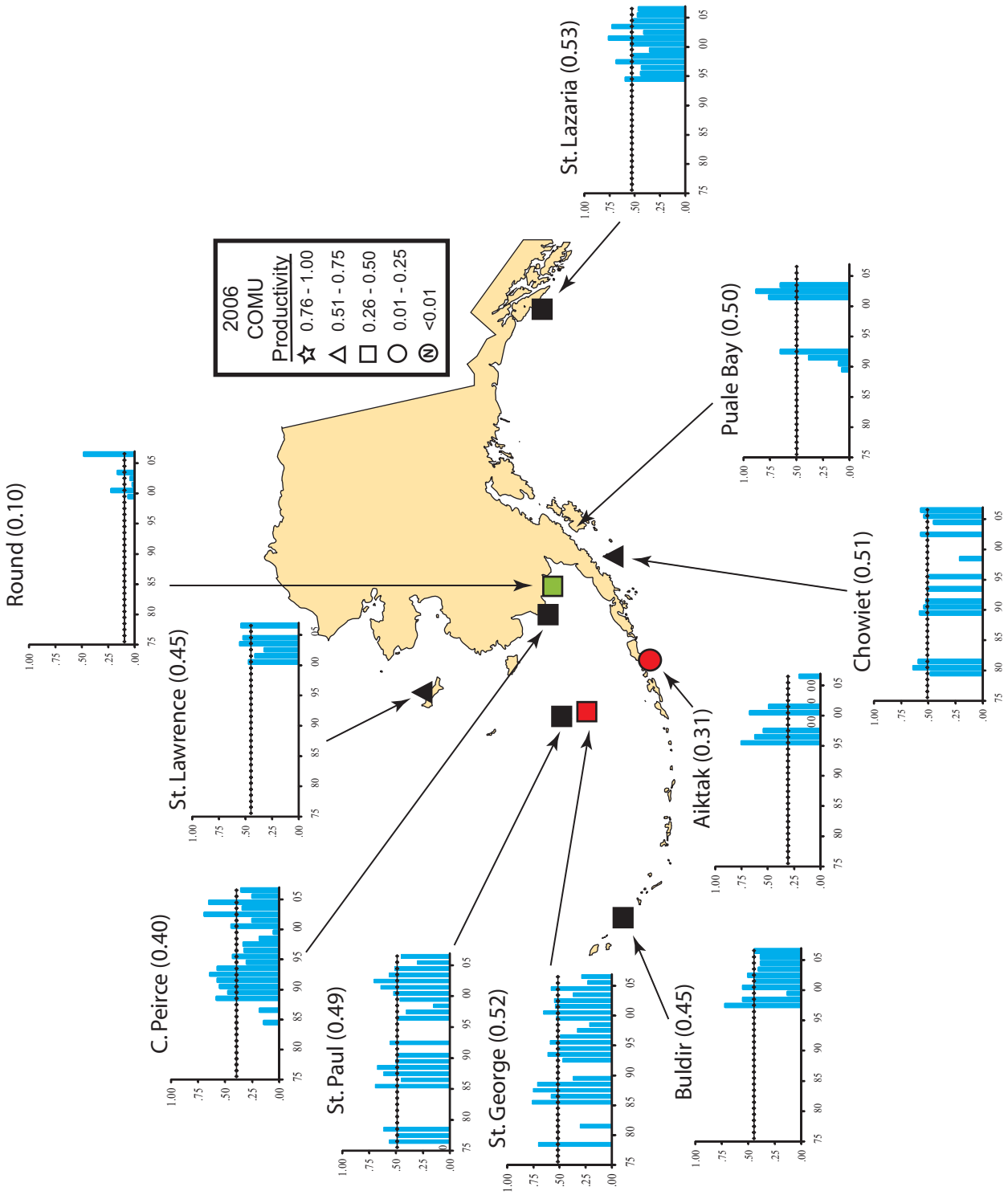


Figure 27. Productivity of common murres (chicks fledged/nest site) at Alaskan sites monitored in 2006. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is > 20% above site mean).

Table 17. Reproductive performance of common murres at Alaskan sites monitored in 2006.

Site	Chicks Fledged/ Nest Site[a]	No. of Plots	Long-term Average	Reference
St. Lawrence I.	0.54	N/A[b] (N/A)[c]	0.45 (5)[c]	Rose 2007
St. Paul I.	0.45	6 (105)	0.49 (21)	Thomson and Spitler 2008
St. George I.	0.29	4 (39)	0.52 (21)	Shannon 2008
Cape Peirce	0.35	9 (125)	0.40 (20)	R. MacDonald Unpubl. Data
Round I.	0.48	2 (43)	0.10 (5)	Okonek and Snively 2006
Buldir I.	0.44	N/A (16)	0.45 (9)	Orben et al. 2006
Aiktak I.	0.20	N/A (5)	0.31 (10)	Helm and Zeman 2006
Chowiet I.	0.57	11 (398)	0.51 (12)	Helm and Zeman 2007
St. Lazaria I.	0.46	N/A (56)	0.53 (12)	Slater and Byrd 2009

[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.

Diet.–Diets collected from Cape Lisburne included a variety of small fish (Fig. 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.

Only prey that occurred in 5% or more of the 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.

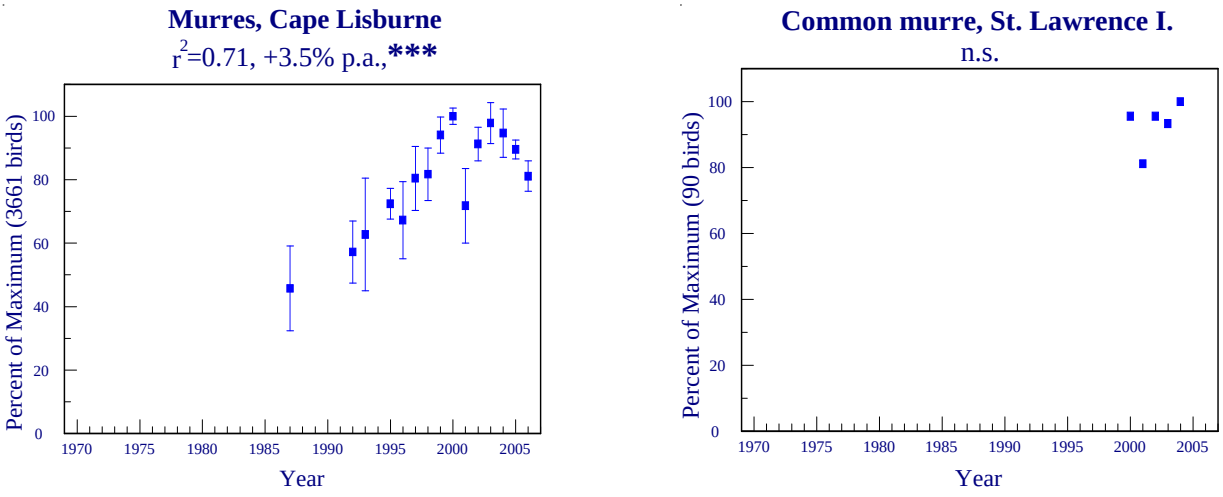


Figure 28. Trends in populations of murres at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Significance of trends indicated as: n.s. p>= 0.05 (not significant), * p<0.05, ** p<0.01, *** p<0.001. Rates of increase or decline are reported as percent change per annum (p.a.).

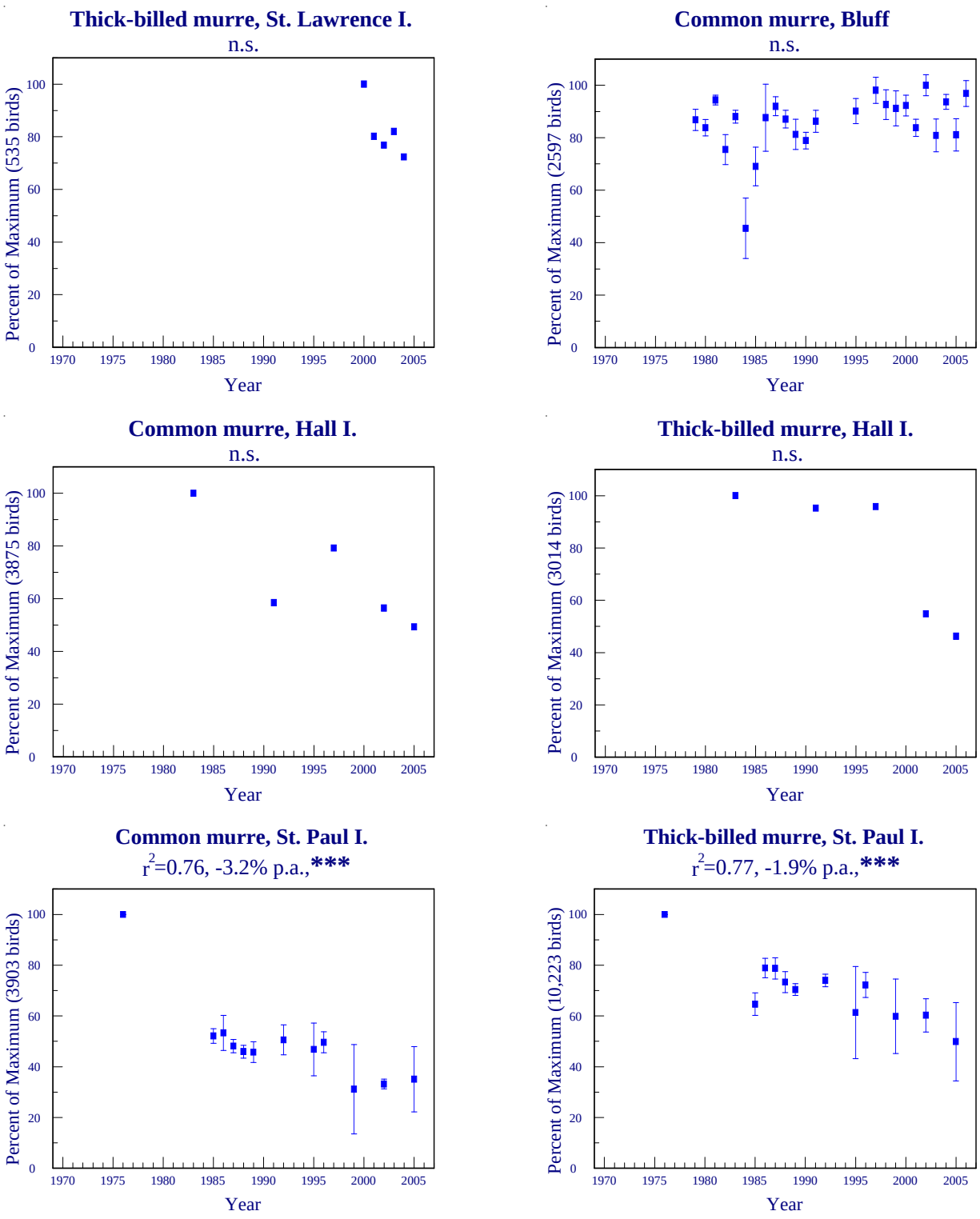


Figure 28 (continued). Trends in populations of murres at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Significance of trends indicated as: n.s. p>= 0.05 (not significant), * p<0.05, ** p<0.01, *** p<0.001. Rates of increase or decline are reported as percent change per annum (p.a.).

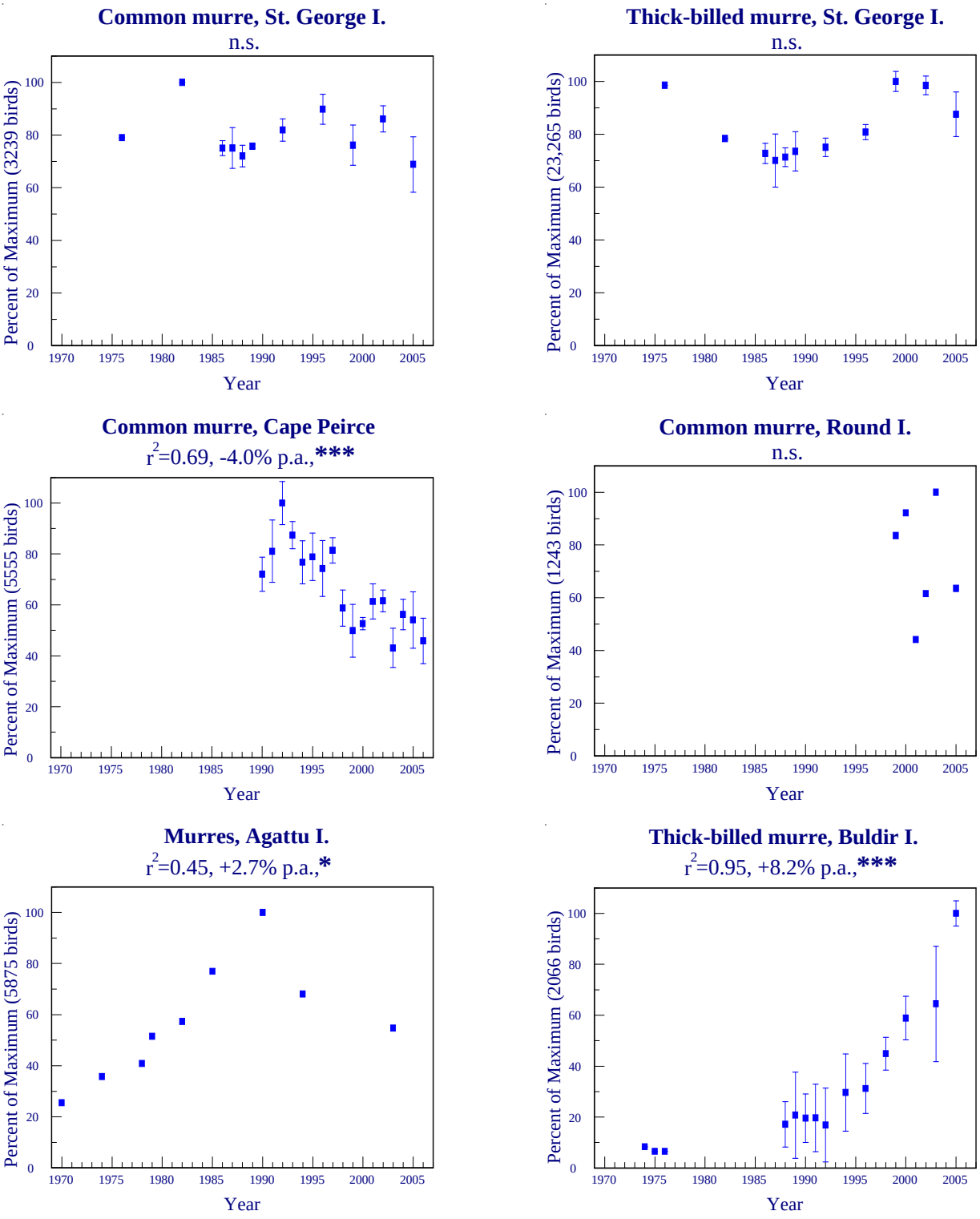


Figure 28 (continued). Trends in populations of murres at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Significance of trends indicated as: n.s. p>= 0.05 (not significant), * p<0.05, ** p<0.01, *** p<0.001. Rates of increase or decline are reported as percent change per annum (p.a.).

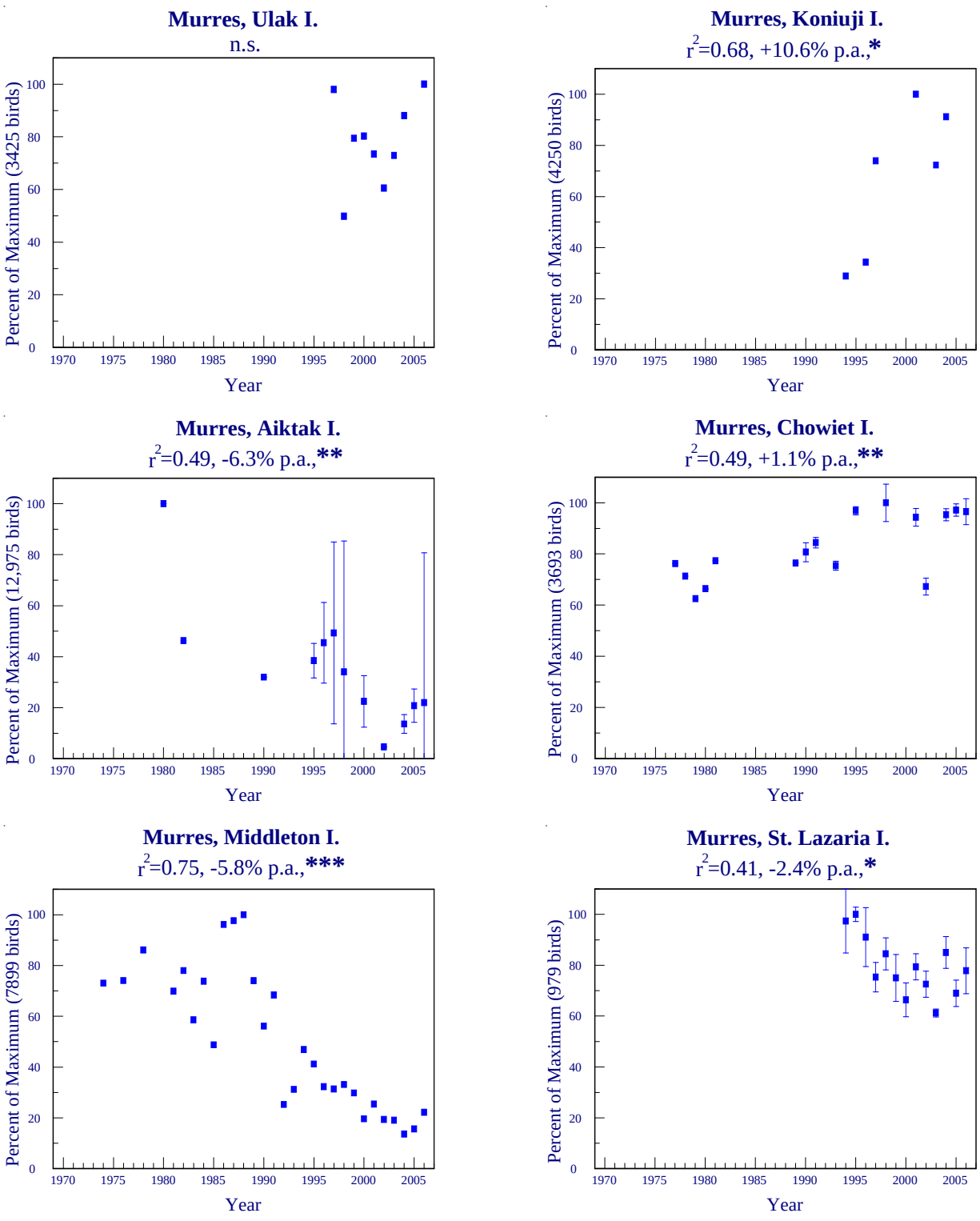


Figure 28 (continued). Trends in populations of murres at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Significance of trends indicated as: n.s. p>= 0.05 (not significant), * p<0.05, ** p<0.01, *** p<0.001. Rates of increase or decline are reported as percent change per annum (p.a.).

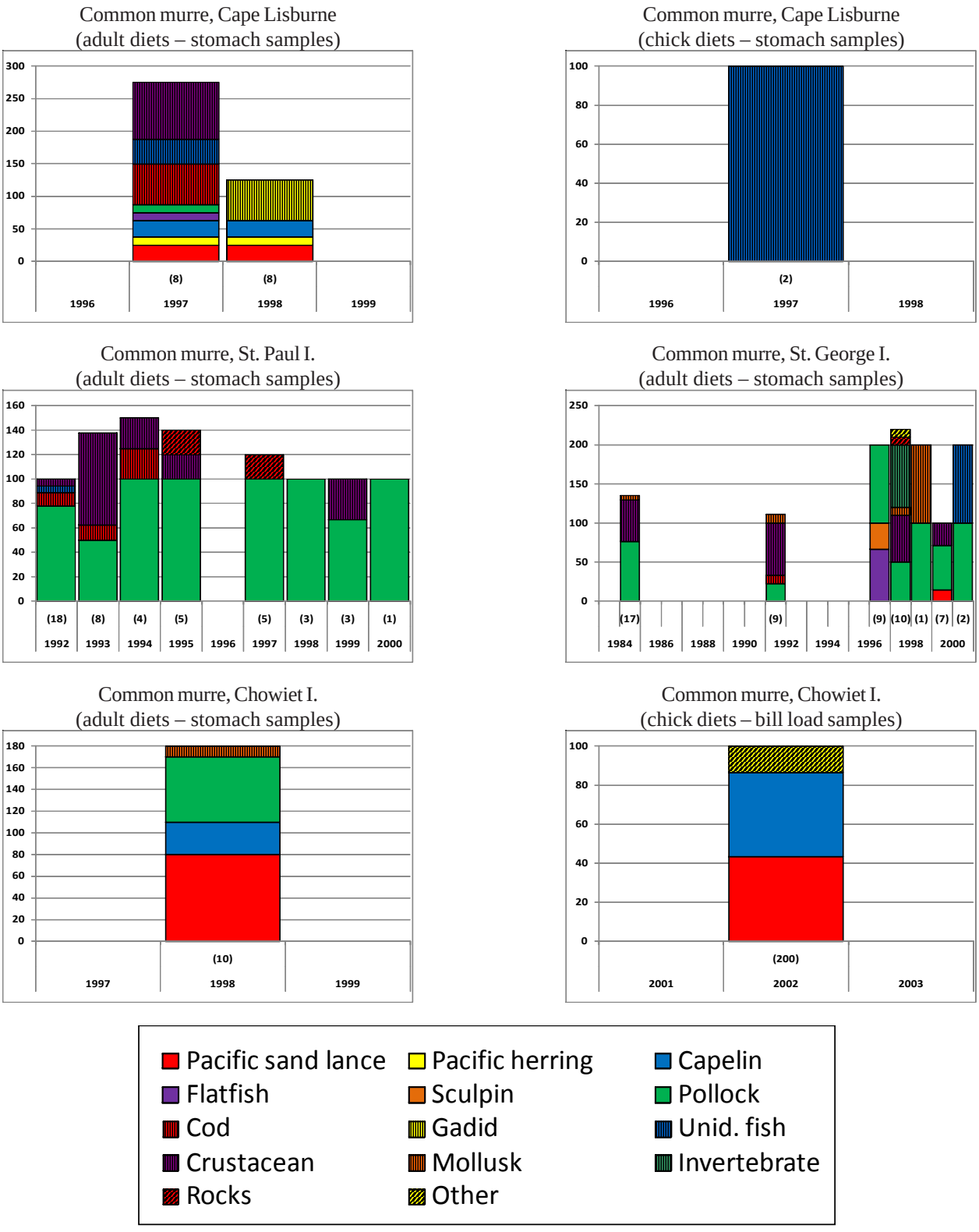


Figure 29. Diets of common murres at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

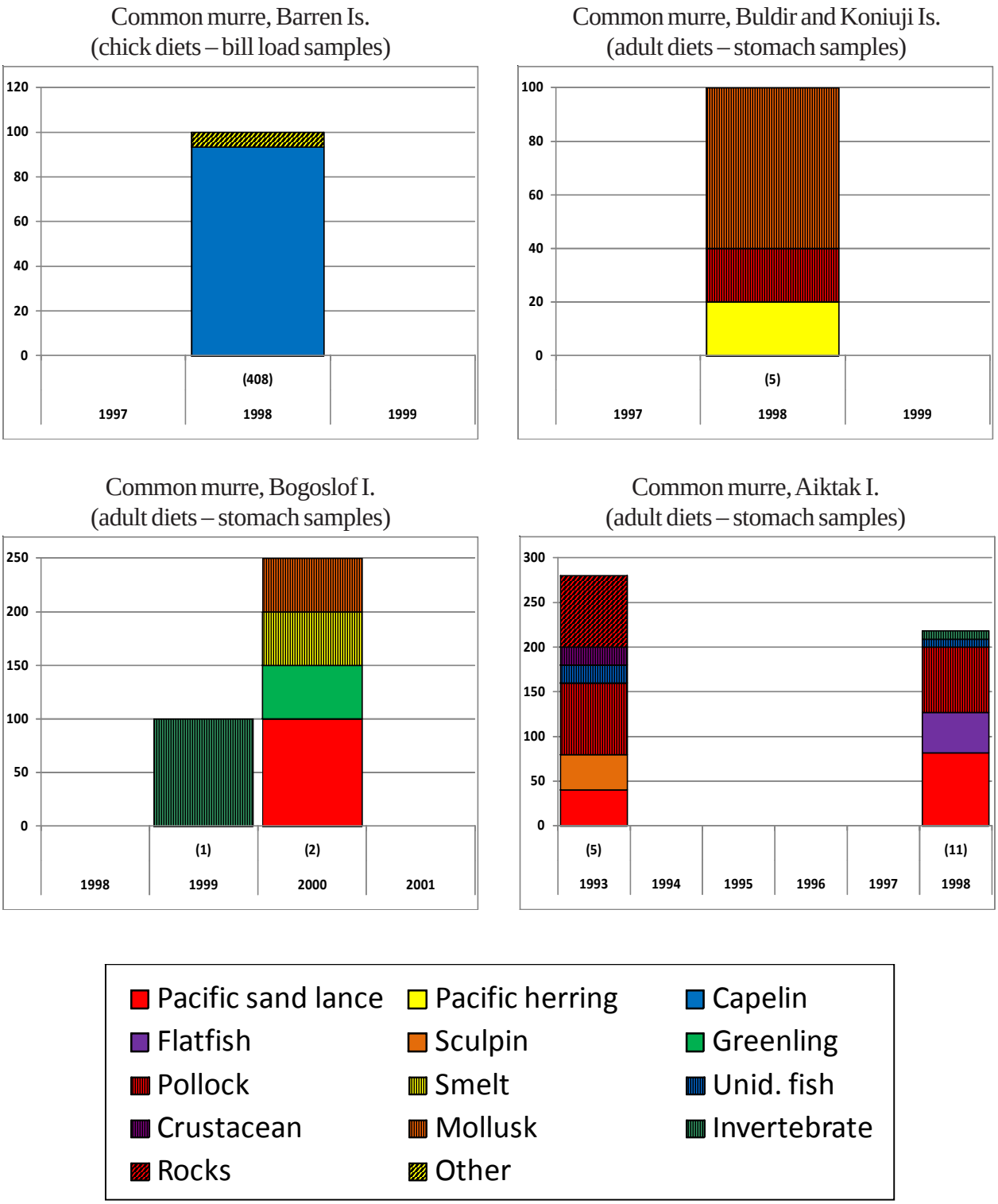


Figure 29 (continued). Diets of common murres at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Thick-billed murre (*Uria lomvia*)

Breeding chronology.–In 2006, thick-billed murre chick hatching was later than average at St. Paul, St. George, Chowiet and St. Lazaria islands, and about average at Buldir Island (Table 18, Fig. 30).

Table 18. Hatching chronology of thick-billed murres at Alaskan sites monitored in 2006.

Site	Median	Mean	Long-term Average	Reference
St. Paul I.	—	15 Aug (131)[a]	6 Aug[b] (21)[a]	Thomson and Spitler 2008
St. George I	—	7 Aug (318)	1 Aug[b] (24)	Shannon 2008
Buldir I.	16 Jul (160)	18 Jul (160)	17 Jul[b] (18)	Orben et al. 2006
Chowiet I.	24 Jul (42)	24 Jul (42)	19 Jul[b] (10)	Helm and Zeman 2007
St. Lazaria I.	—	14 Aug (13)	9 Aug[b] (12)	Slater and Byrd 2009

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

Productivity.–Thick-billed murre rates of success in 2006 were average at most monitored colonies (Table 19, Fig. 31). Productivity was below average at St. Lawrence Island and above average at Aiktak Island.

Table 19. Reproductive performance of thick-billed murres at Alaskan sites monitored in 2006.

Site	Chicks Fledged/ Nest Site[a]	No. of Plots	Long-term Average	Reference
St. Lawrence I.	0.37	N/A[b] (N/A)[c]	0.52 (5)[c]	Rose 2007
St. Paul I.	0.45	18 (316)	0.45 (22)	Thomson and Spitler 2008
St. George I.	0.44	21 (318)	0.52 (24)	Shannon 2008
Buldir I.	0.67	8 (271)	0.65 (18)	Orben et al. 2006
Aiktak I.	0.40	N/A (10)	0.27 (10)	Helm and Zeman 2006
Chowiet I.	0.48	5 (116)	0.42 (12)	Helm and Zeman 2007
St. Lazaria I.	0.46	N/A (26)	0.45 (12)	Slater and Byrd 2009

[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.–Thick-billed murres declined at St. Paul Island (-1.9% per annum) and increased at Buldir Island (+8.2% per annum, Fig. 28). No trends were evident for this species at other monitored colonies.

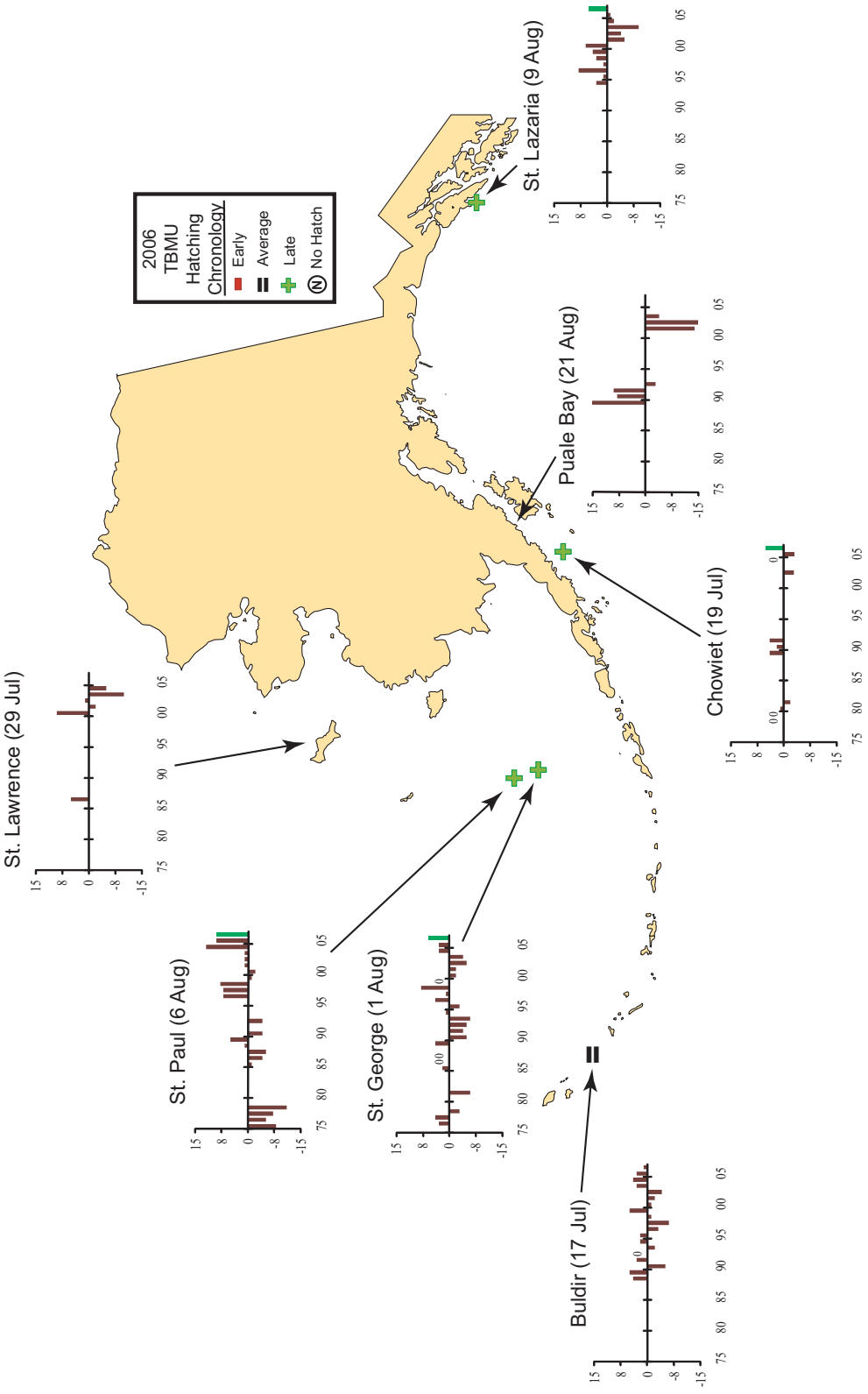


Figure 30. Hatching chronology of thick-billed murres at Alaskan sites monitored in 2006. Graphs indicate the departure in days (if any), from the site mean (in parentheses; current year not included).

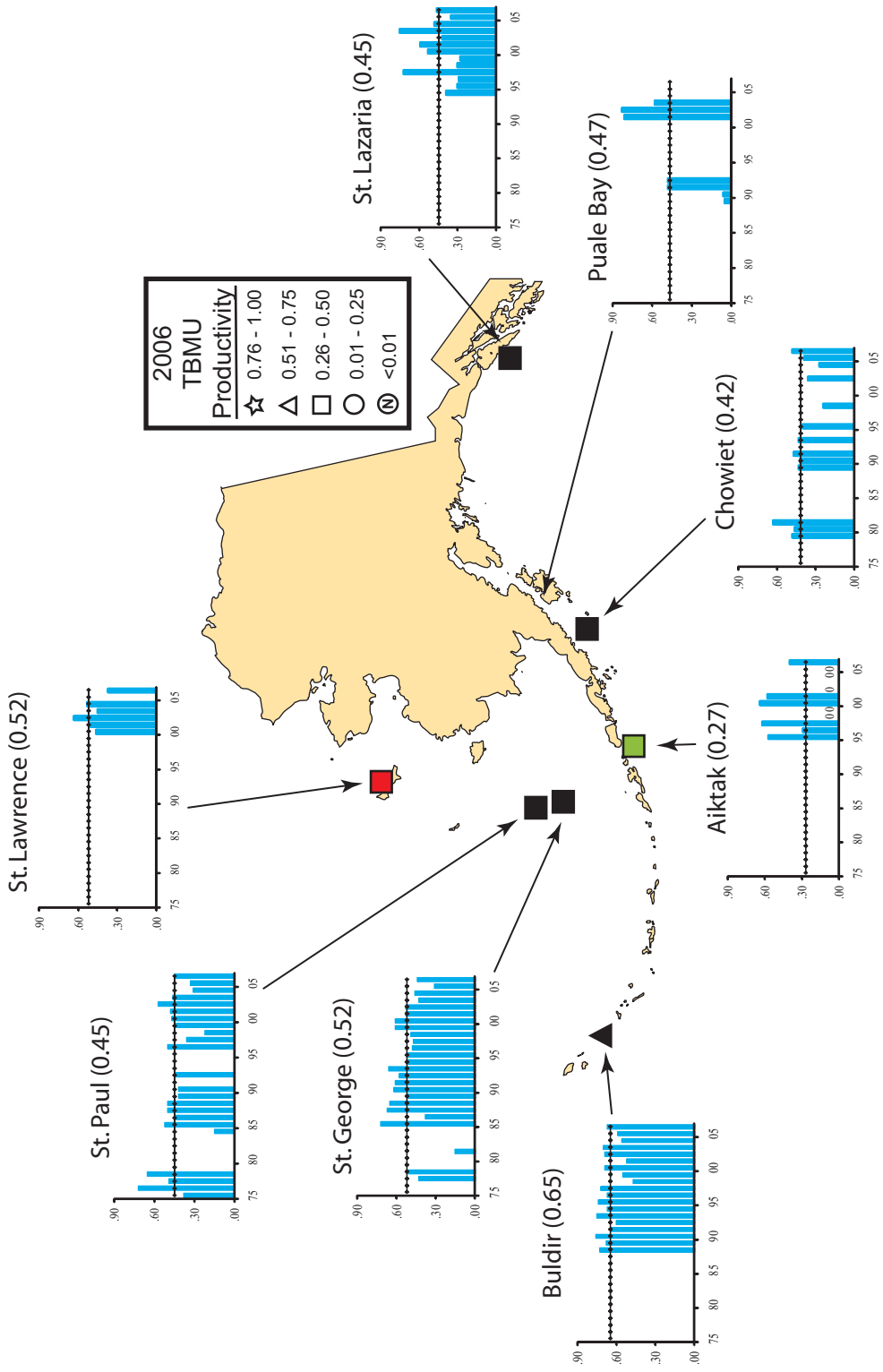


Figure 31. Productivity of thick-billed murres (chicks fledged/nest site) at Alaskan sites monitored in 2006. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current 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 (Fig. 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 sandlance, capelin, and squid.

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.

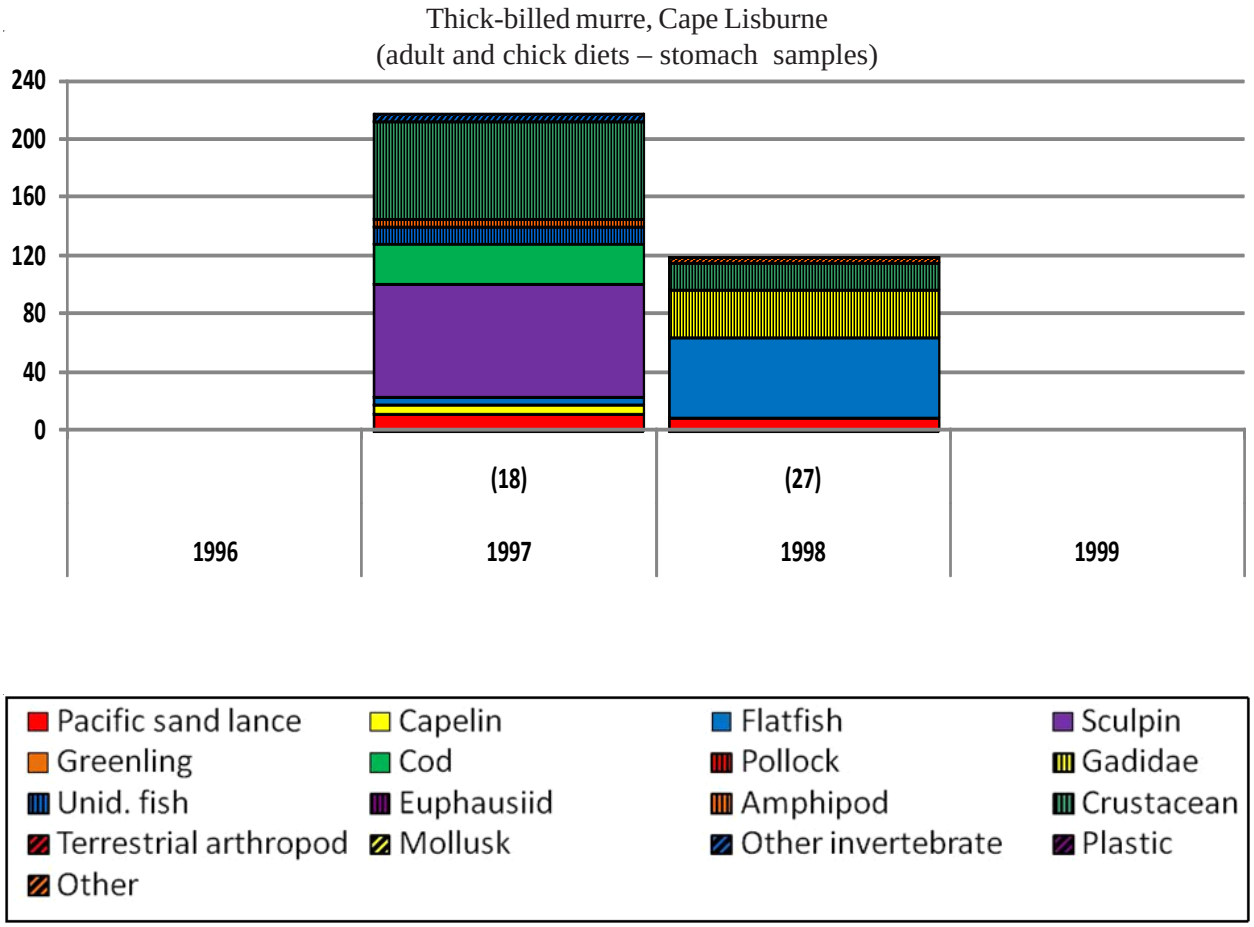


Figure 32. Diets of thick-billed murres at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

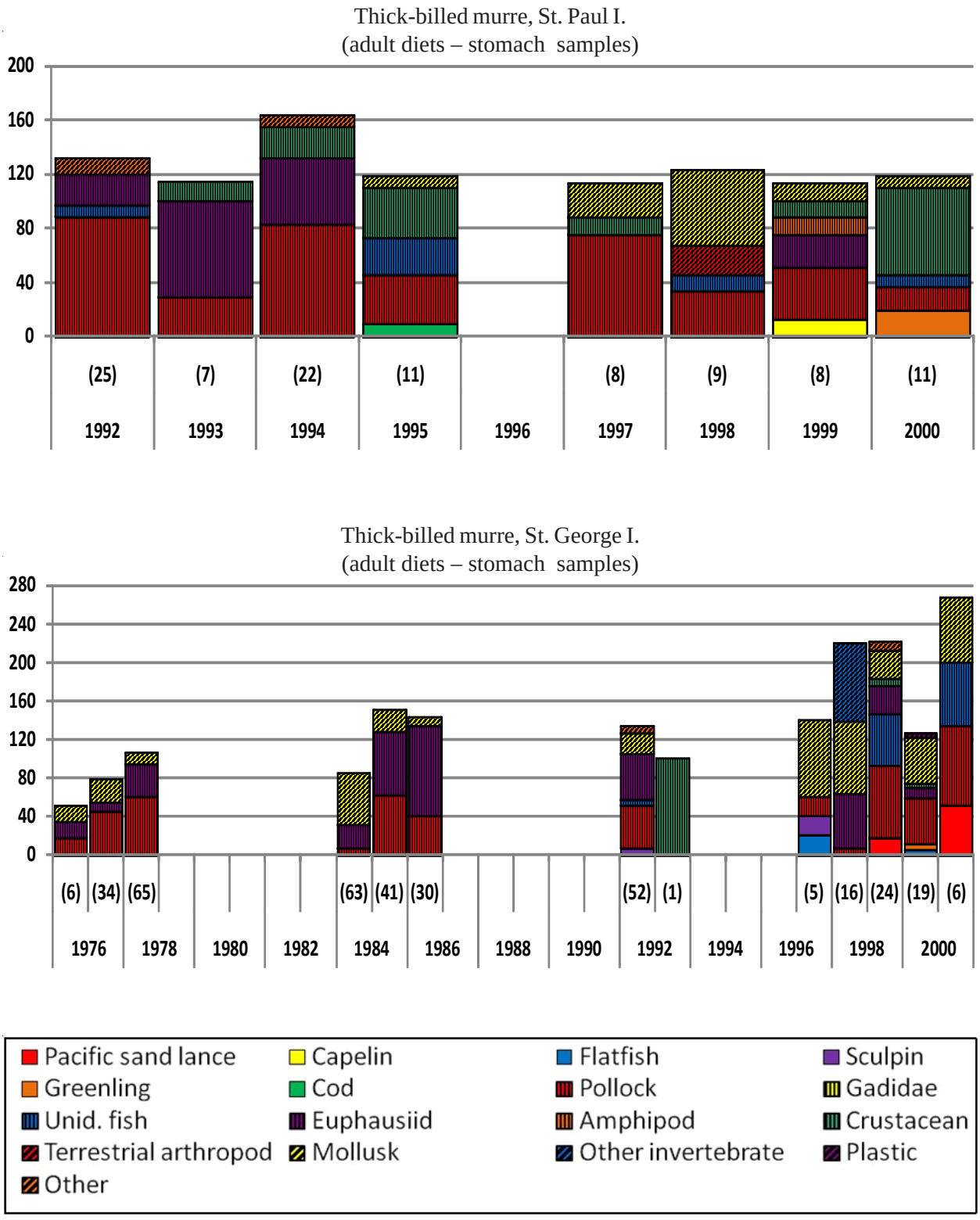


Figure 32 (continued). Diets of thick-billed murres atAlaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

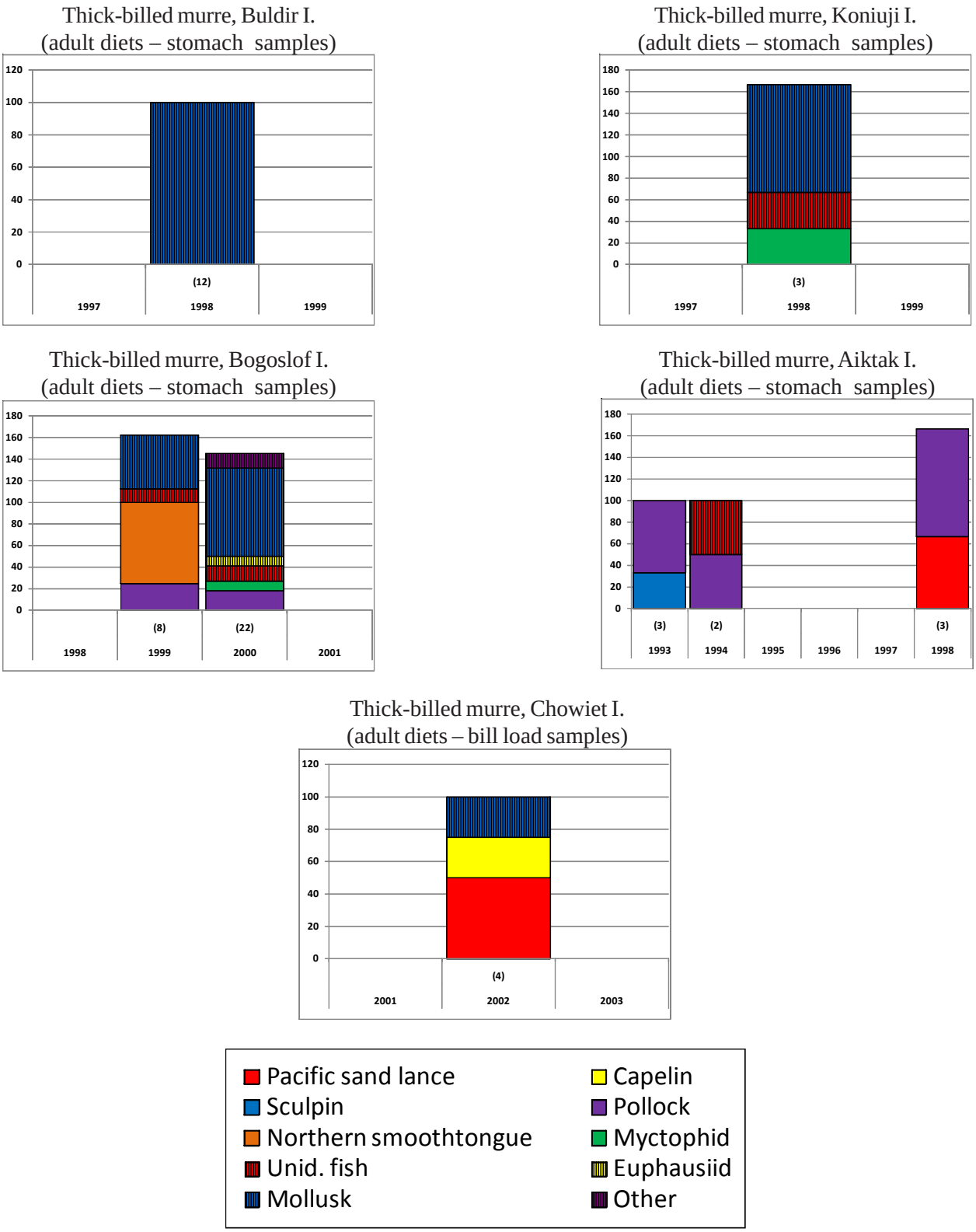


Figure 32 (continued). Diets of thick-billed murres atAlaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Pigeon guillemot (*Cepphus columba*)

Breeding chronology.–No data.

Productivity.–No data.

Populations.–We found a significant negative population trend for pigeon guillemots in Prince William Sound (-6.1% per annum), but not for populations at other sites (Fig. 33).

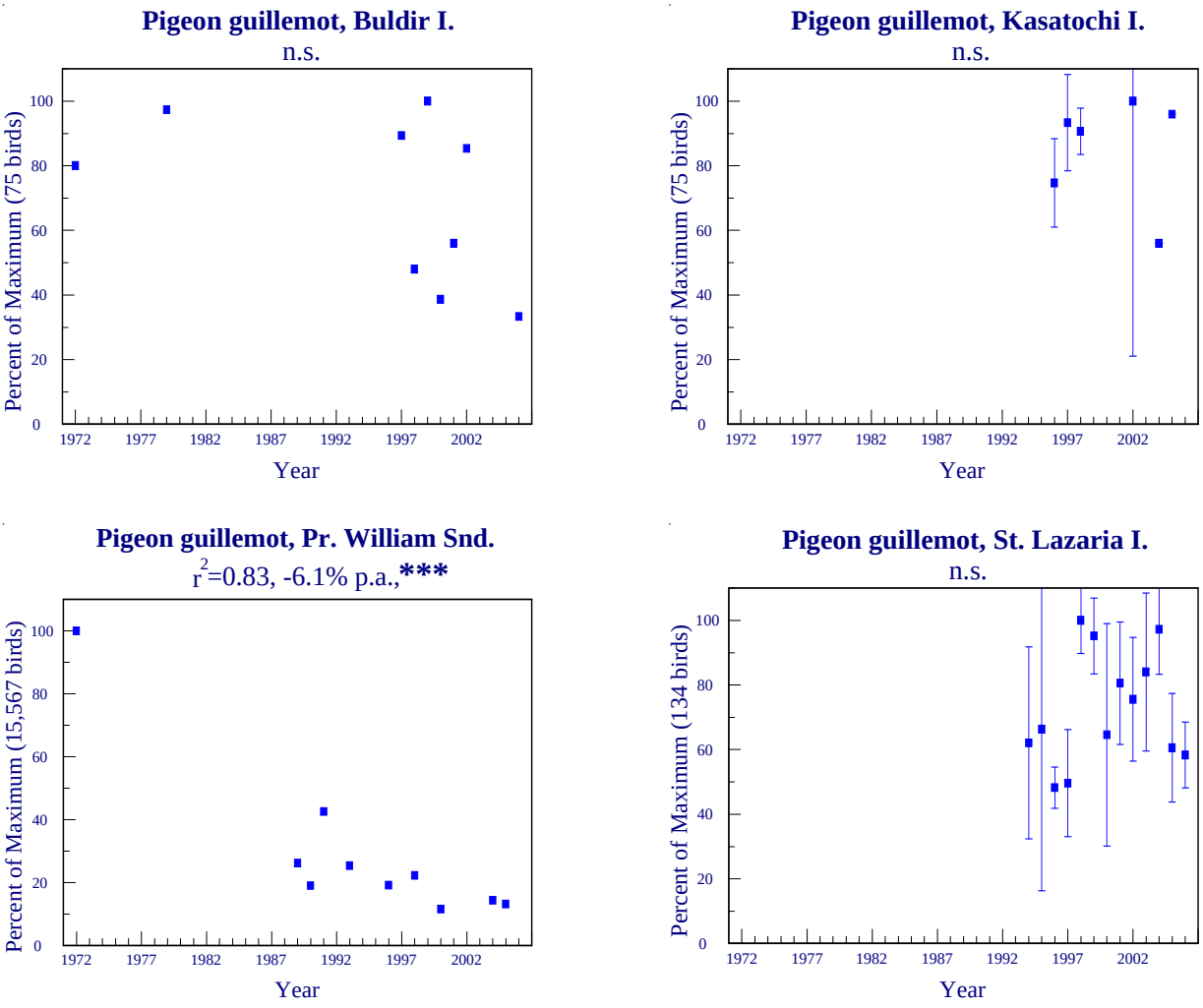


Figure 33. Trends in populations of pigeon guillemots at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Significance of trends indicated as: n.s. p>= 0.05 (not significant), * p<0.05, ** p<0.01, *** p<0.001. Rates of increase or decline are reported as percent change per annum (p.a.).

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

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.

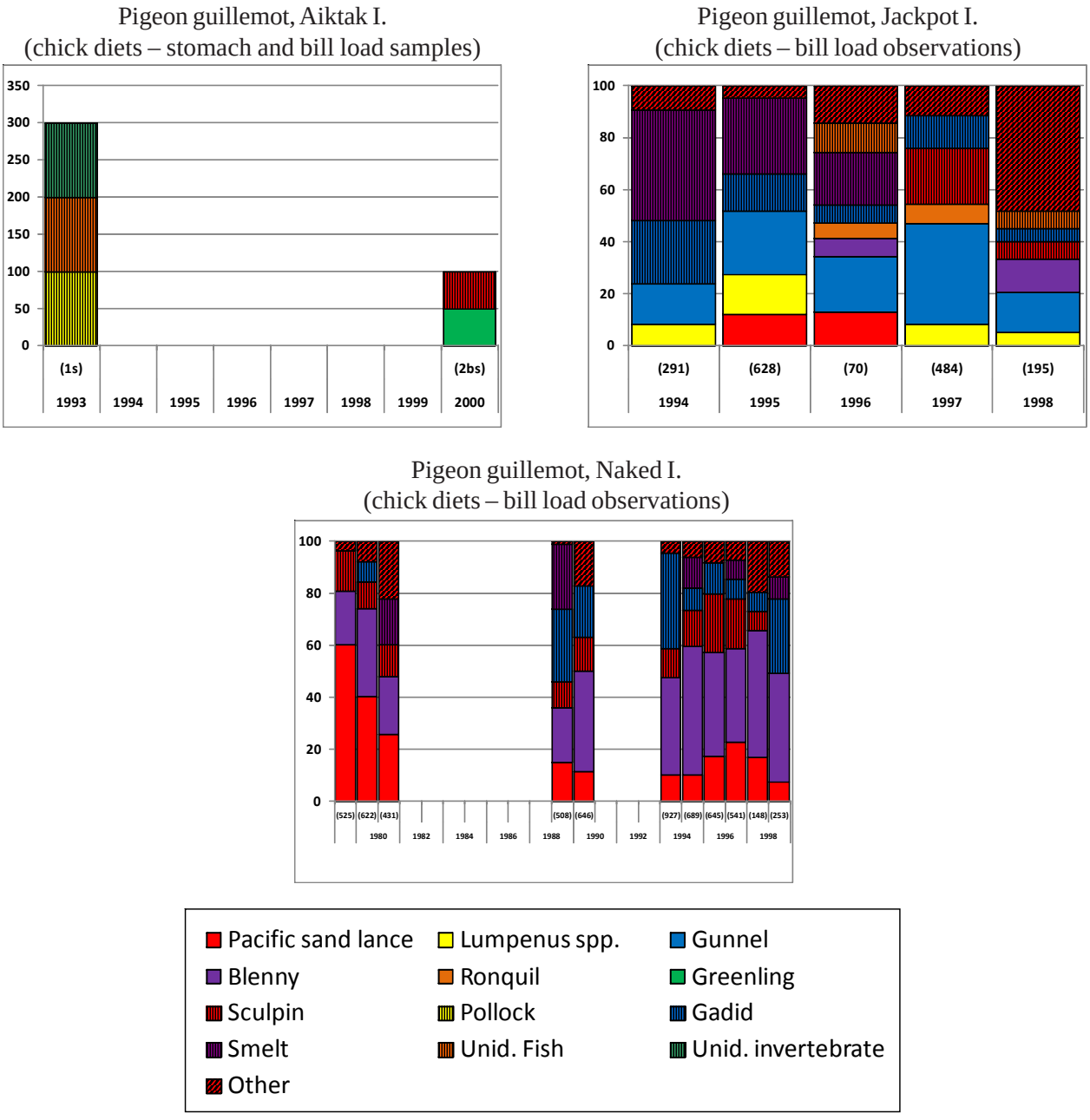


Figure 34. Diets of pigeon guillemots at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar. Because Prince William Sound samples were reported as 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 later than average at Aiktak Island, the only site where this species was monitored in 2006 (Table 20).

Table 20. Hatching chronology of ancient murrelets at Alaskan sites monitored in 2006.

Site	Median	Mean	Long-term Average	Reference
Aiktak I.	—	7 Jul (41)[a]	3 Jul[b] (9)[a]	Helm and Zeman 2006

[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 above average at Aiktak Island, the only site where this species was monitored in 2006 (Table 21).

Table 21. Reproductive performance of ancient murrelets at Alaskan sites monitored in 2006.

Site	Chicks Fledged/Egg[a]	No. of Plots	Long-term Average	Reference
Aiktak I.	0.91	N/A[b] (88)[c]	0.75 (9)[c]	Helm and Zeman 2006

[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 later than average at Buldir Island and early at Chowiet Island in 2006 (Table 22).

Table 22. Hatching chronology of parakeet auklets at Alaskan sites monitored in 2006.

Site	Median	Mean	Long-term Average	Reference
Buldir I.	8 Jul (13)[a]	9 Jul (13)	4 Jul[b] (14)[a]	Orben et al. 2006
Chowiet I.	3 Jul (7)	2 Jul (7)	8 Jul[b] (2)	Helm and Zeman 2007

[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 2006, parakeet auklet productivity was above average at Buldir and Chowiet islands (Table 23).

Table 23. Reproductive performance of parakeet auklets at Alaskan sites monitored in 2006.

Site	Chicks Fledged/ Nest Site[a]	No. of Plots	Long-term Average	Reference
Buldir I.	0.83	N/A[b] (41)[c]	0.46 (14)[c]	Orben et al. 2006
Chowiet I.	0.67	N/A (24)	0.22 (3)	Helm and Zeman 2007

[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 the copepods; euphausiids were also an important prey type in later years (Fig. 35). In a small sample from Kasatochi Island, diet consisted entirely of copepods.

Only prey that occurred in 5% or more of the 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.

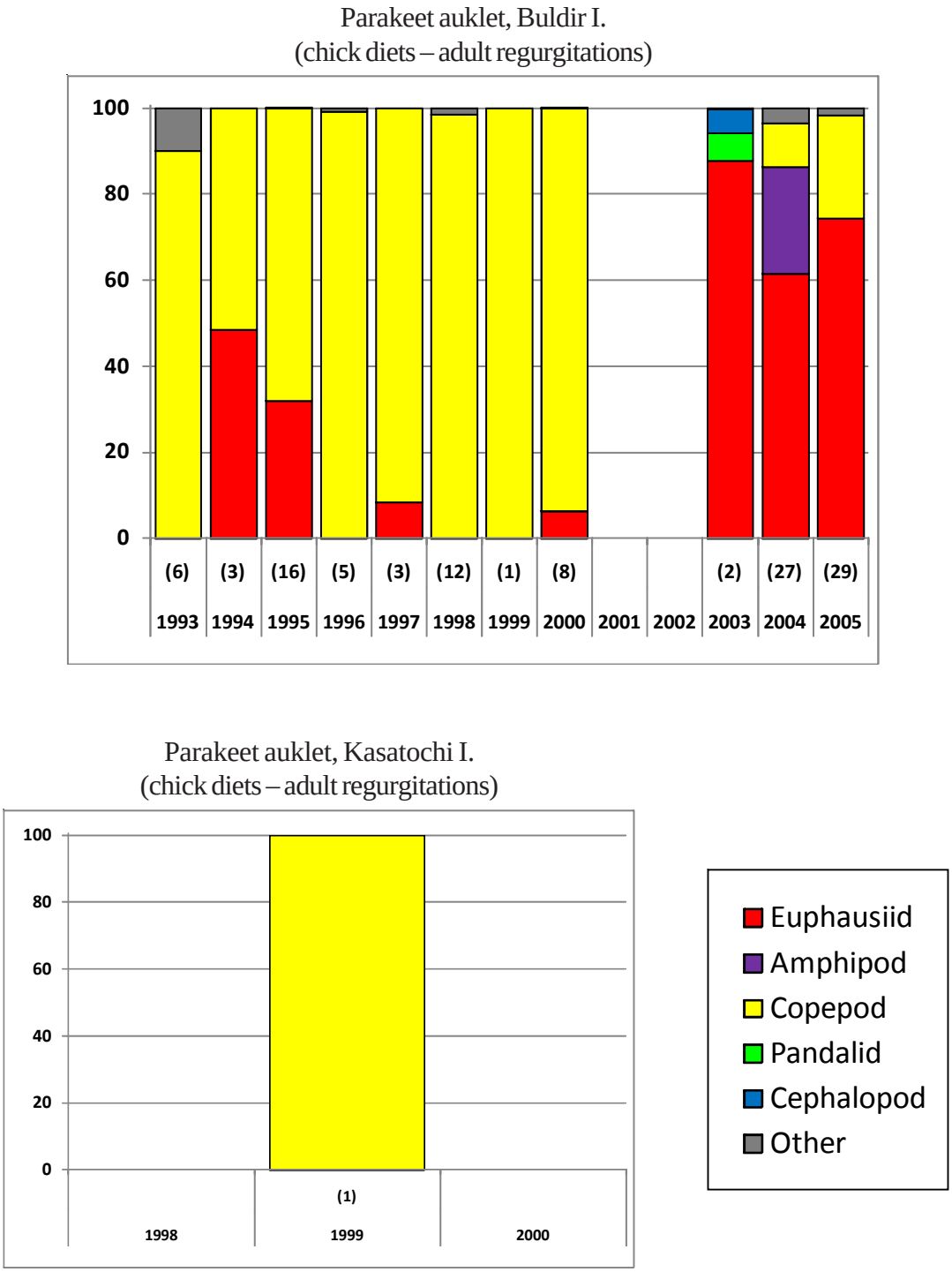


Figure 35. Diets of parakeet auklets at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent biomass of prey type in the diet. Sample sizes are reported below each bar.

Least auklet (*Aethia pusilla*)

Breeding chronology.–The dates of hatching for least auklets were about average at Buldir Island and late at Kasatochi Island in 2006 (Table 24, Fig. 36).

Table 24. Hatching chronology of least auklets at Alaskan sites monitored in 2006.

Site	Median	Mean	Long-term Average	Reference
Buldir I.	27 Jun (34)[a]	30 Jun (34)	28 Jun[b] (16)[a]	Orben et al. 2006
Kasatochi I.	3 Jul (42)	3 Jul (42)	29 Jun[b] (10)	Drummond 2006

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

Productivity.–Least auklet reproductive success was lower than average at St. Lawrence Island, above average at Buldir Island and about average at Kasatochi Island in 2006 (Table 25, Fig. 37).

Table 25. Reproductive performance of least auklets at Alaskan sites monitored in 2006.

Site	Chicks Fledged/ Nest Site[a]	No. of Plots	Long-term Average	Reference
St. Lawrence I.	0.39	N/A[b] (N/A)[c]	0.68 (6)[c]	Rose 2007
Buldir I.	0.75	N/A (84)	0.53 (16)	Orben et al. 2006
Kasatochi I.	0.44	N/A (77)	0.55 (10)	Drummond 2006

[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 least auklets at St. Lawrence Island consisted mostly of copepods (Fig. 38). 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 Semisnopochnoi islands consisted primarily of copepods.

Only prey that occurred in 5% or more of the 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.

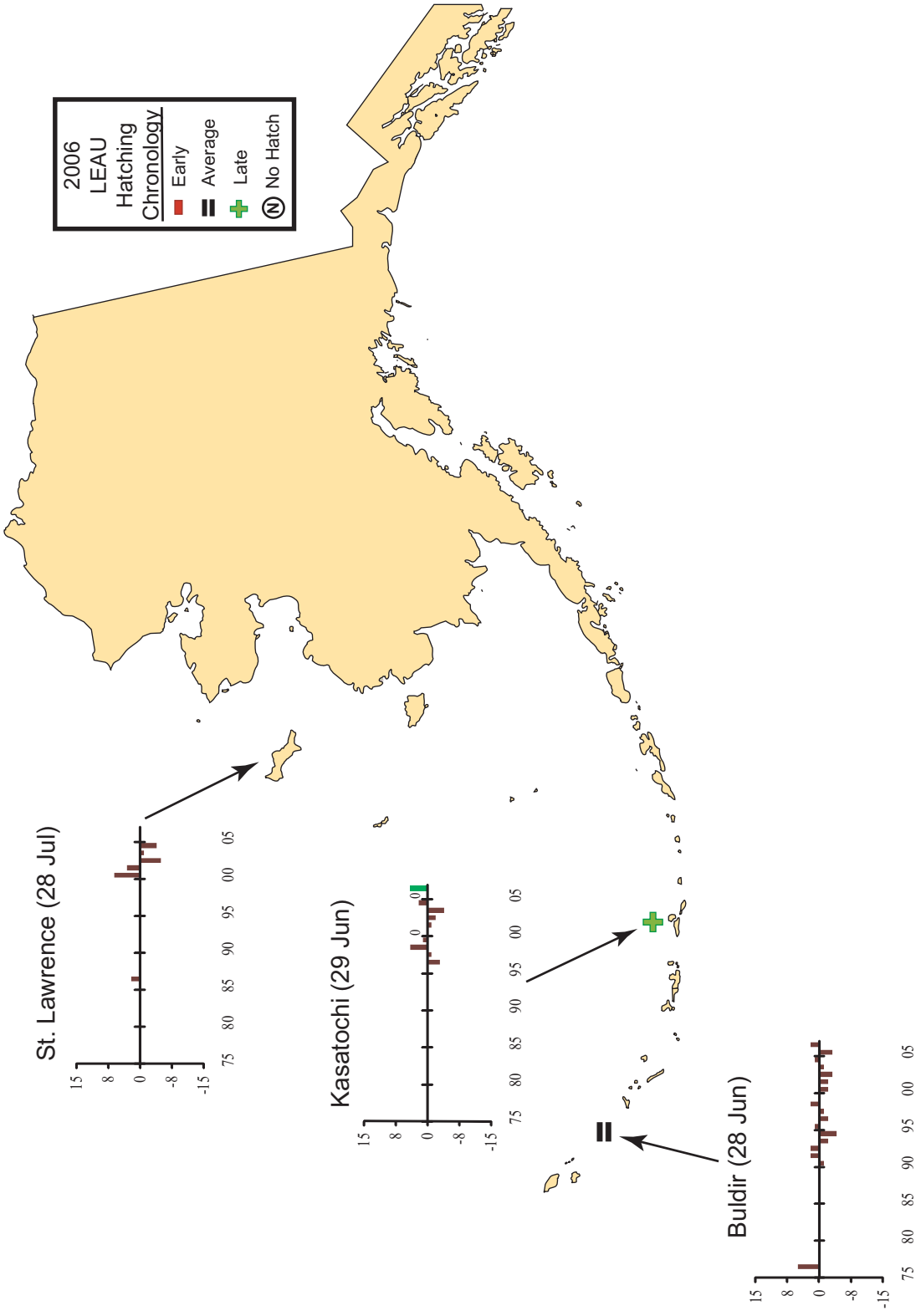


Figure 36. Hatching chronology of least auklets at Alaskan sites monitored in 2006. Graphs indicate the departure in days (if any), from the site mean (in parentheses; current year not included).

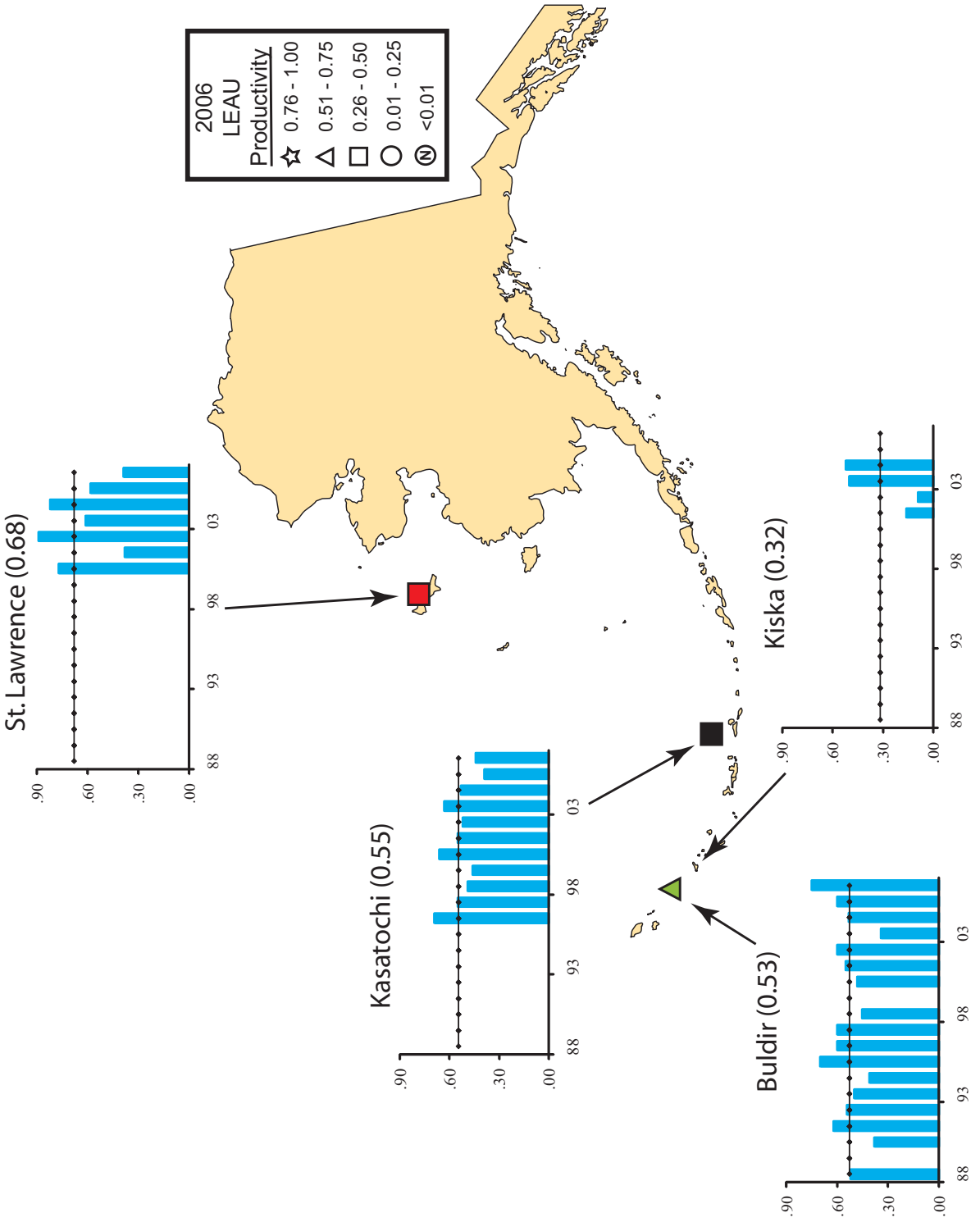


Figure 37. Productivity of least auklets (chicks fledged/nest site) at Alaskan sites monitored in 2006. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is > 20% above site mean).

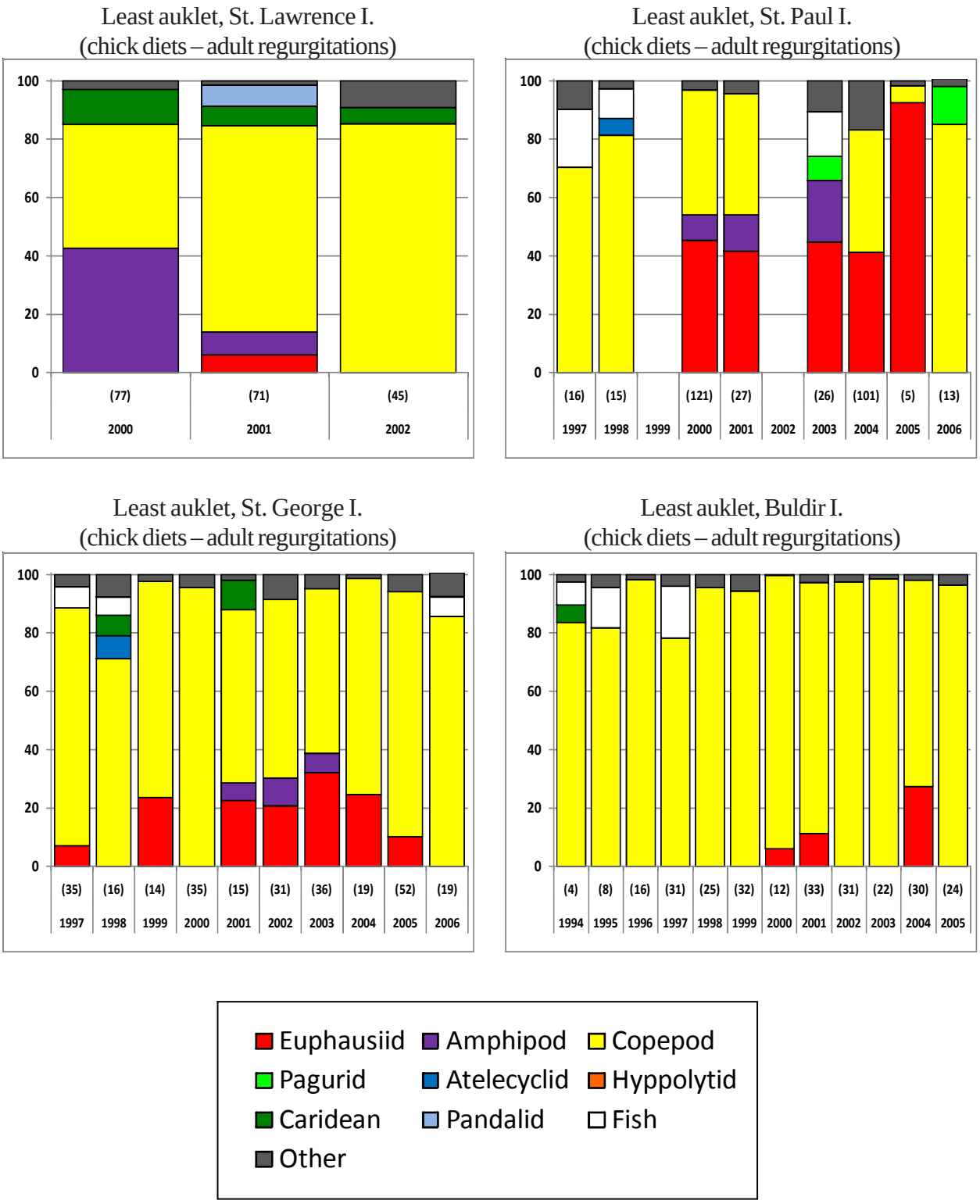


Figure 38. Diets of least auklets at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent biomass of prey type in the diet. Sample sizes are reported below each bar.

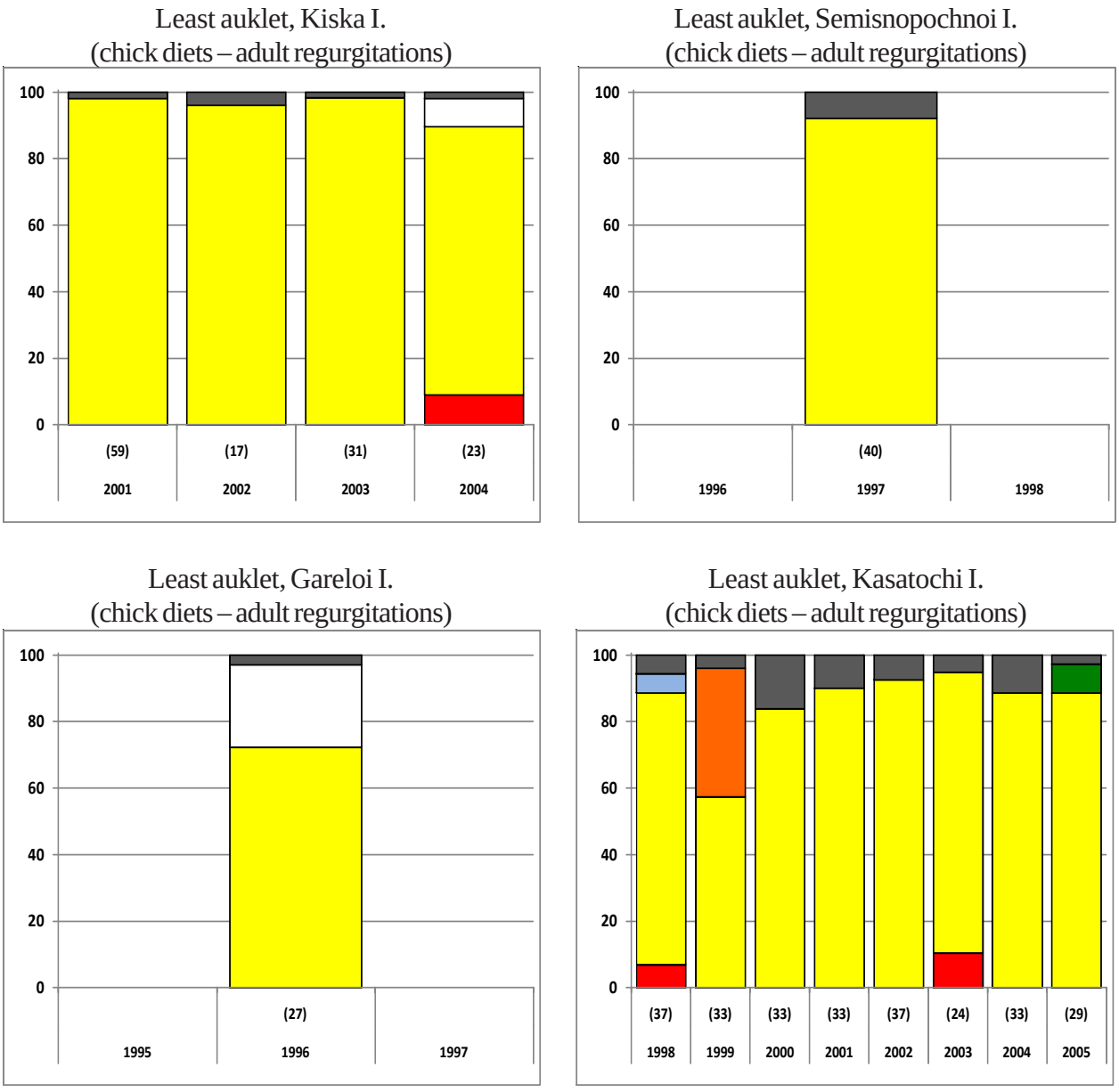


Figure 38 (continued). Diets of least auklets at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent biomass of prey type in the diet. Sample sizes are reported below each bar.

Whiskered auklet (*Aethia pygmaea*)

Breeding chronology.–The mean hatching date for whiskered auklets was later than average at Buldir Island, the only site where this species was monitored in 2006 (Table 26).

Table 26. Hatching chronology of whiskered auklets at Alaskan sites monitored in 2006.

Site	Median	Mean	Long-term Average	Reference
Buldir I.	27 Jun (20)[a]	27 Jun (20)	23 Jun[b] (16)[a]	Orben et al. 2006

[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 at Buldir Island was about average for this species at the only site at which it was monitored in 2006 (Table 27).

Table 27. Reproductive performance of whiskered auklets at Alaskan sites monitored in 2006.

Site	Chicks Fledged/ Nest Site[a]	No. of Plots	Long-term Average	Reference
Buldir I.	0.62	N/A[b] (68)[c]	0.58 (15)[c]	Orben et al. 2006

[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 (Fig 39).

Only prey that occurred in 5% or more of the 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.

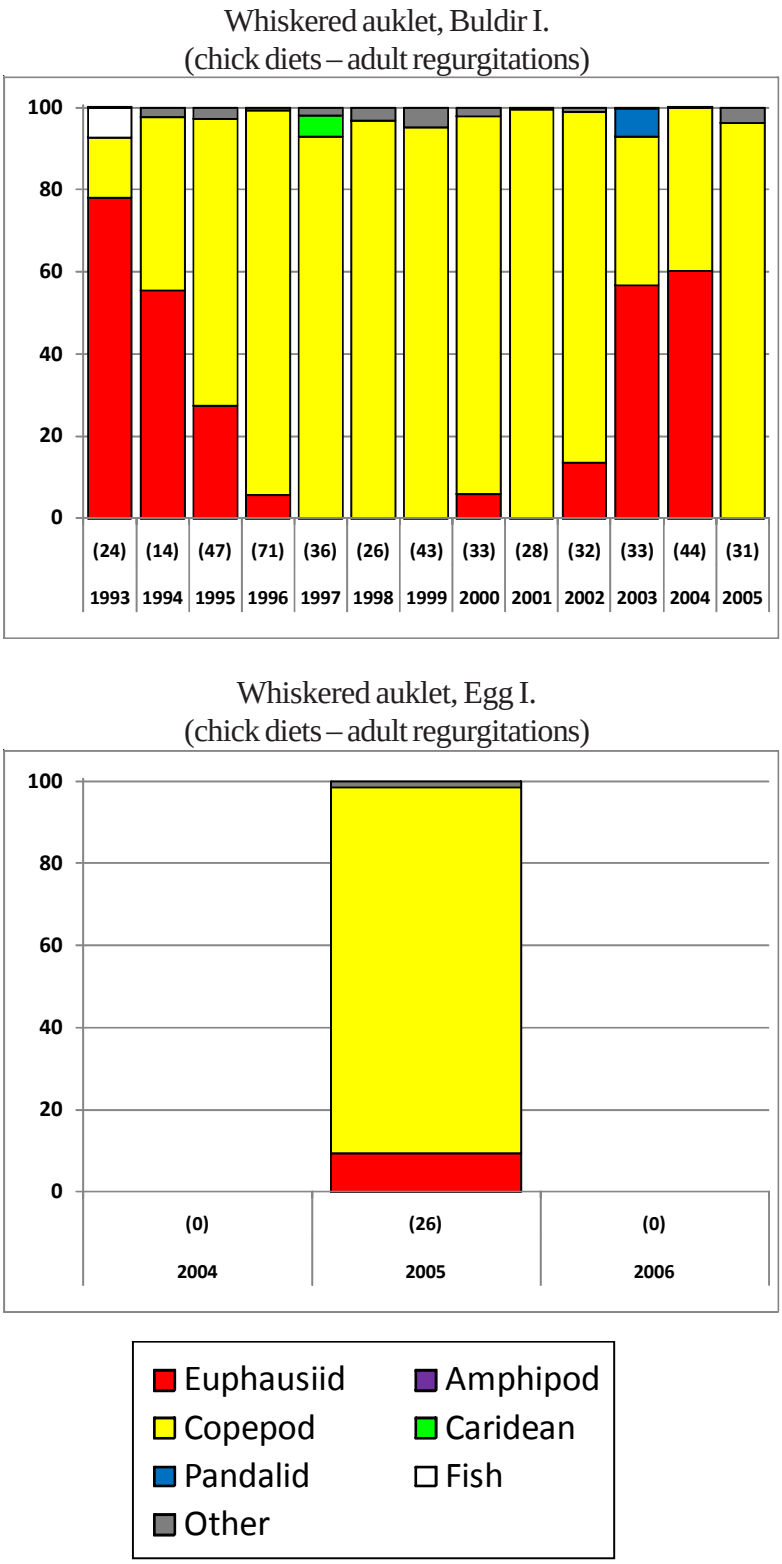


Figure 39. Diets of whiskered auklets at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent biomass of prey type in the diet. Sample sizes are reported below each bar.

Crested auklet (*Aethia cristatella*)

Breeding chronology.–The mean date of hatching for crested auklets in 2006 was late at Buldir and Kasatochi islands (Table 28, Fig. 40).

Table 28. Hatching chronology of crested auklets at Alaskan sites monitored in 2006.

Site	Median	Mean	Long-term Average	Reference
Buldir I.	10 Jul (28)[a]	9 Jul (28)	29 Jun[b] (16)[a]	Orben et al. 2006
Kasatochi I.	3 Jul (55)	5 Jul (55)	1 Jul[b] (10)	Drummond 2006

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

Productivity.–Crested auklets exhibited below average productivity at St. Lawrence Island and about average success at Buldir and Kasatochi islands in 2006 (Table 29, Fig. 41).

Table 29. Reproductive performance of crested auklets at Alaskan sites monitored in 2006.

Site	Chicks Fledged/ Nest Site[a]	No. of Plots	Long-term Average	Reference
St. Lawrence I.	0.46	N/A[b] (N/A)[c]	0.70 (6)[c]	Rose 2007
Buldir I.	0.64	N/A (73)	0.61 (16)	Orben et al. 2006
Kasatochi I.	0.66	N/A (88)	0.64 (10)	Drummond 2006

[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.–Crested auklets at St. Lawrence and Kiska islands primarily ate euphausiids (Fig. 42). 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.

Only prey that occurred in 5% or more of the 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.

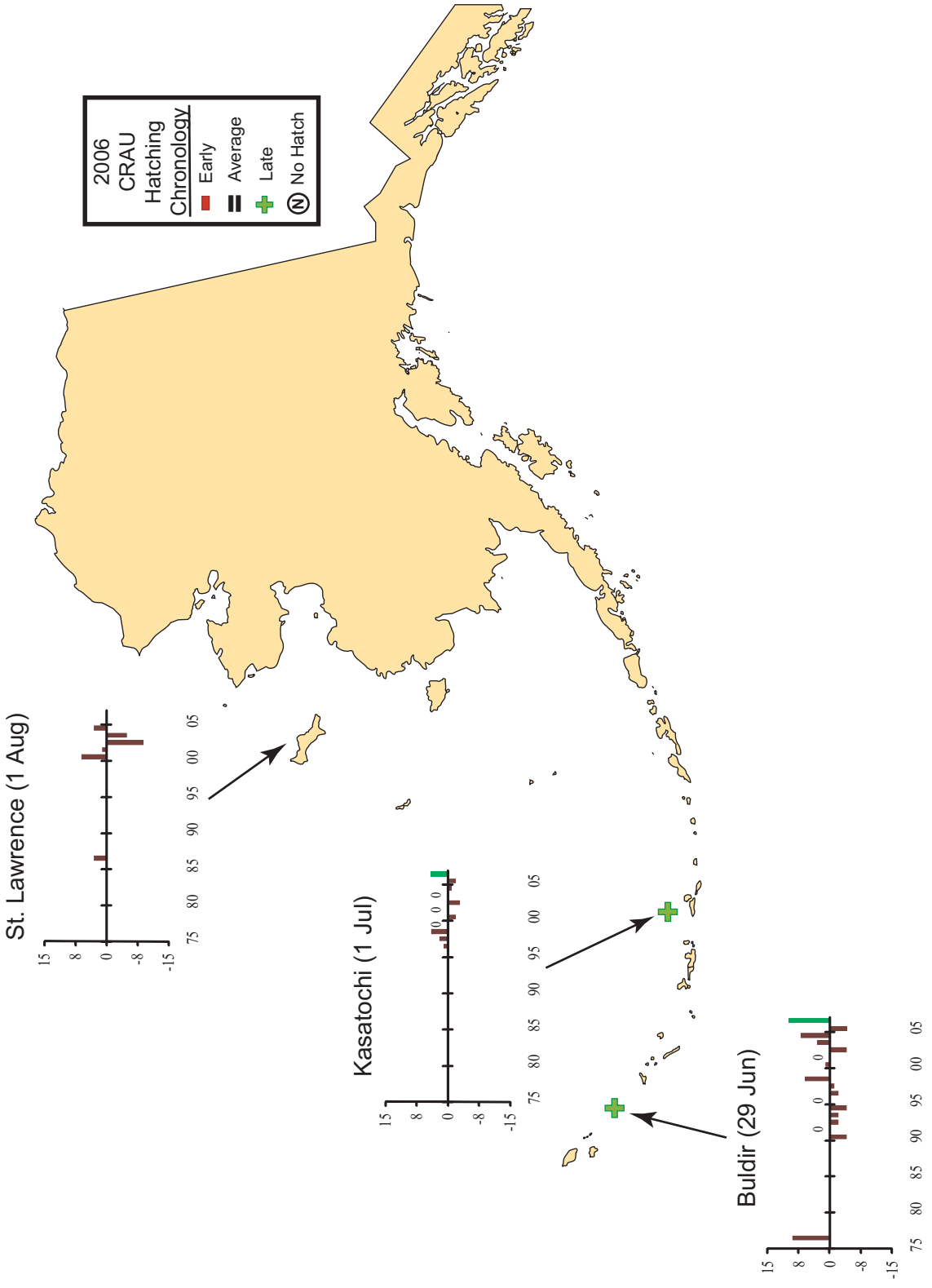


Figure 40. Hatching chronology of crested auklets at Alaskan sites monitored in 2006. Graphs indicate the departure in days (if any), from the site mean (in parentheses; current year not included).

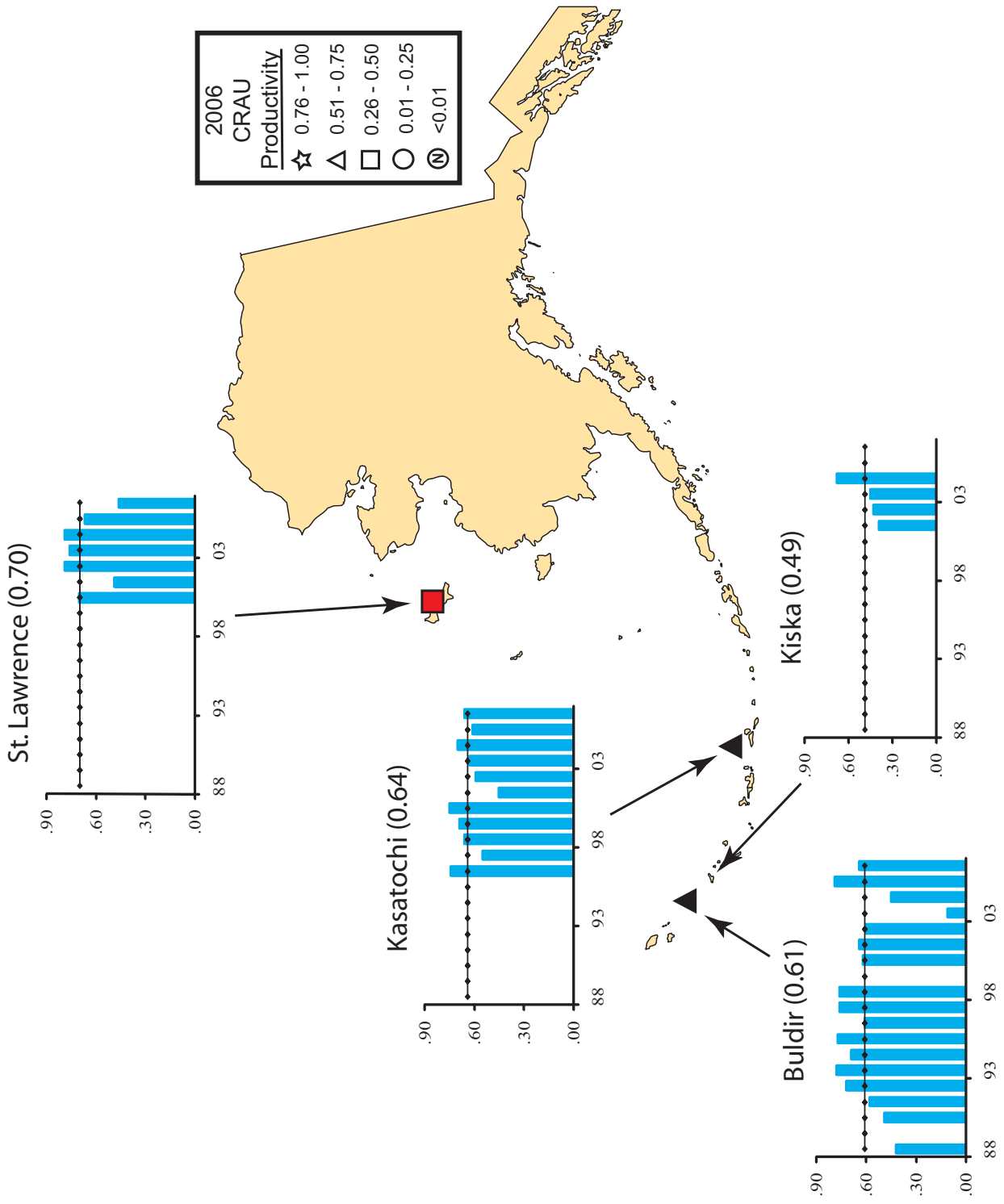


Figure 41. Productivity of crested auklets (chicks fledged/nest site) at Alaskan sites monitored in2006. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is > 20% above site mean).

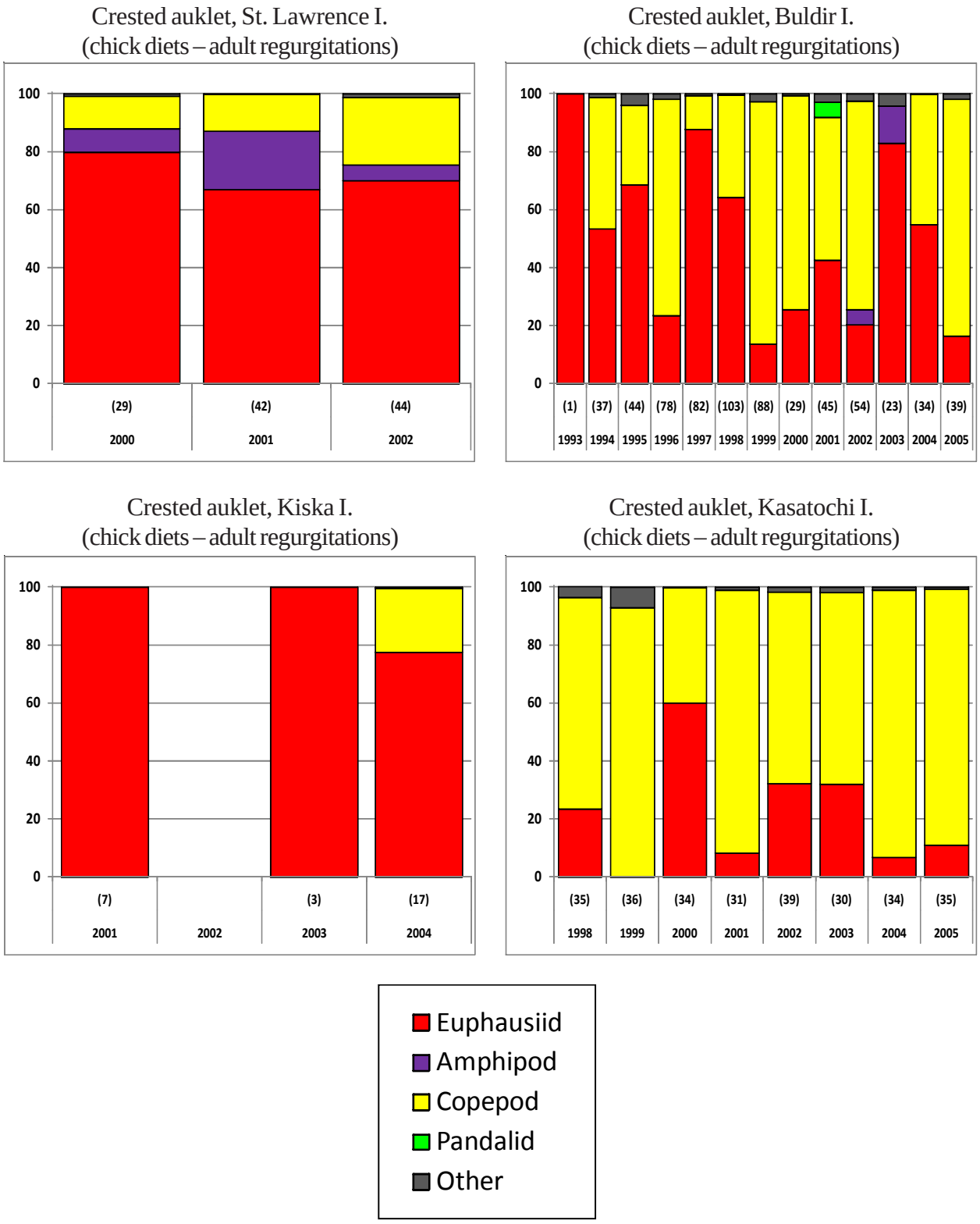


Figure 42. Diets of crested auklets at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent biomass of prey type in the diet. Sample sizes are reported below each bar.

Rhinoceros auklet (*Cerorhinca monocerata*)

Breeding chronology.–Mean hatch date for rhinoceros auklets was about average at St. Lazaria Island in 2006 (Table 30).

Table 30. Hatching chronology of rhinoceros auklets at Alaskan sites monitored in 2006.

Site	Median	Mean	Long-term Average	Reference
St. Lazaria I.	—	28 Jun (10)[a]	25 Jun[b] (11)[a]	Slater and Byrd 2009

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

Productivity.–Productivity was above average at St. Lazaria Island in 2006 (Table 31).

Table 31. Reproductive performance of rhinoceros auklets at Alaskan sites monitored in 2006.

Site	Chicks Fledged/Egg	No. of Plots	Long-term Average	Reference
St. Lazaria I.	0.68	N/A[a] (N/A)[b]	0.45 (12)[b]	Slater and Byrd 2009

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

Populations.–We found a significant positive trend (+4.7% per annum) in populations of rhinoceros auklets at St. Lazaria Island (Fig. 43).

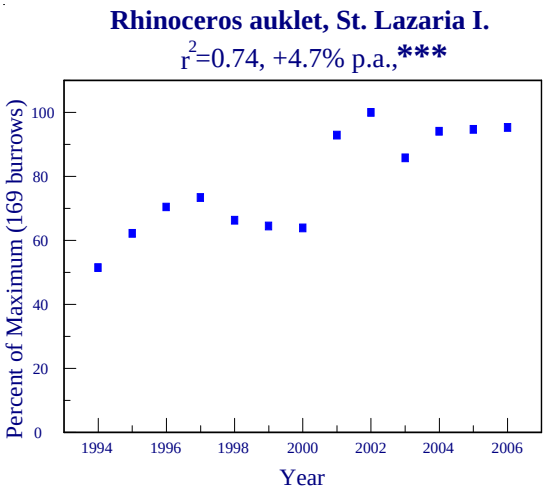


Figure 43. Trends in populations of rhinoceros auklets at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Significance of trends indicated as: n.s. p>= 0.05 (not significant), * p<0.05, ** p<0.01, *** p<0.001. Rates of increase or decline are reported as percent change per annum (p.a.).

Diet.–Diets collected from rhinoceros auklets on Chowiet and Middleton islands were dominated by sandlance (Fig. 44). Rhinoceros auklets from St. Lazaria Island ate primarily sandlance, capelin, and herring, with other small fish making up most of the rest of the diet.

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.

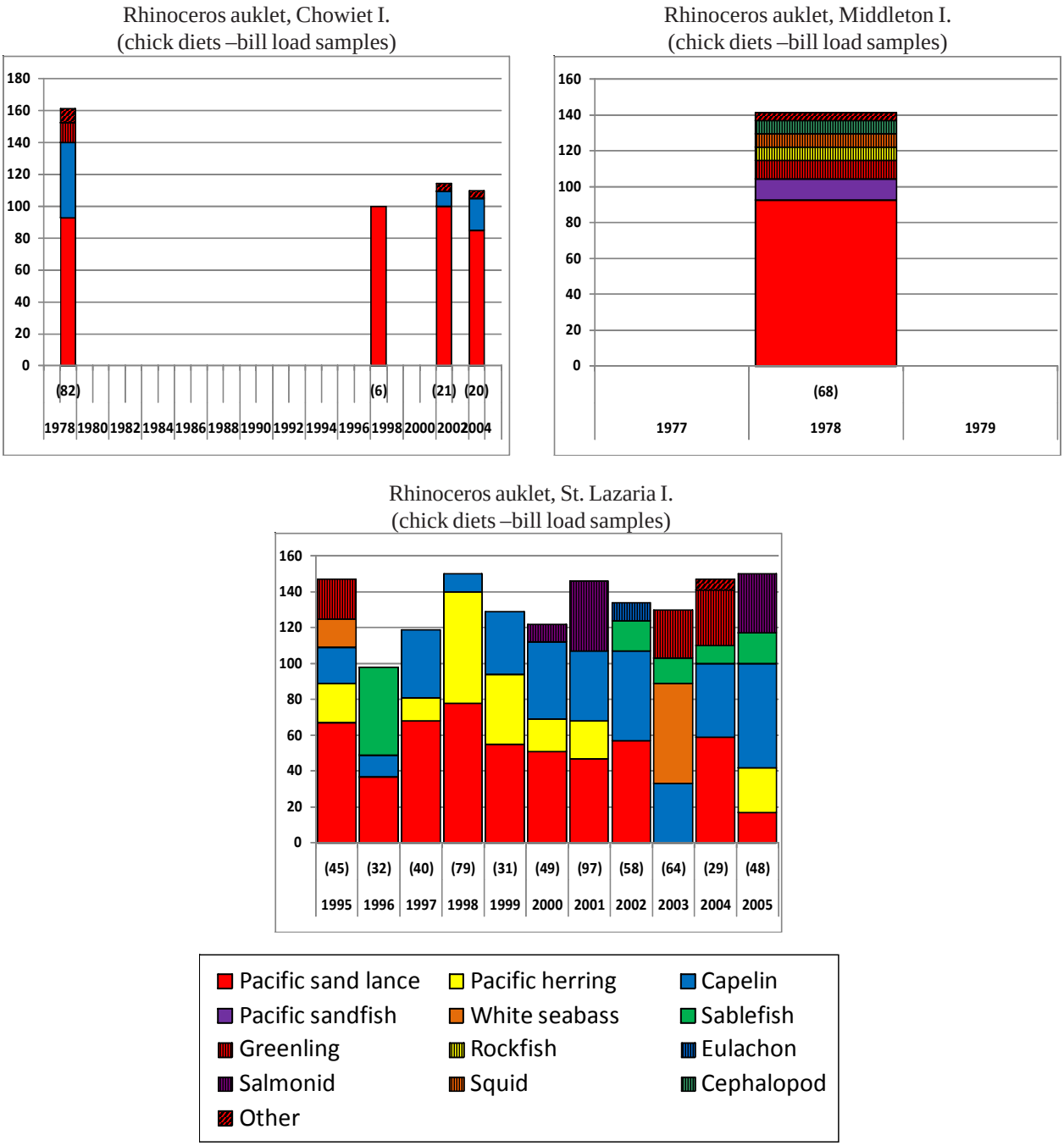


Figure 44. Diets of rhinoceros auklets at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Horned puffin (*Fratercula corniculata*)

Breeding chronology.–Horned puffin breeding chronology was early at Aiktak Island and about average at Buldir and Chowiet islands in 2006 (Table 32, Fig. 45).

Table 32. Hatching chronology of horned puffins at Alaskan sites monitored in 2006.

Site	Median	Mean	Long-term Average	Reference
Buldir I.	25 Jul (24)[a]	26 Jul (24)	24 Jul[b] (18)[a]	Orben et al. 2006
Aiktak I.	22 Jul (5)	27 Jul (5)	3 Aug[b] (4)	Helm and Zeman 2006
Chowiet I.	31 Jul (31)	31 Jul (31)	28 Jul[b] (3)	Helm and Zeman 2007

[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 all monitored sites in 2006 (Table 33, Fig. 46).

Table 33. Reproductive performance of horned puffins at Alaskan sites monitored in 2006.

Site	Chicks Fledged/Egg	No. of Plots	Long-term Average	Reference
Buldir I.	0.52	N/A[a] (42)[b]	0.42 (22)[b]	Orben et al. 2006
Aiktak I.	0.56	N/A (9)	0.37 (6)	Helm and Zeman 2006
Chowiet I.	0.48	N/A (40)	0.34 (3)	Helm and Zeman 2007

[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 (Fig. 47). Horned puffins on Buldir Island ate primarily greenling and sandlance; 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 on the Semidi Islands ate predominately sand lance.

Only prey that occurred in 5% or more of the 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.

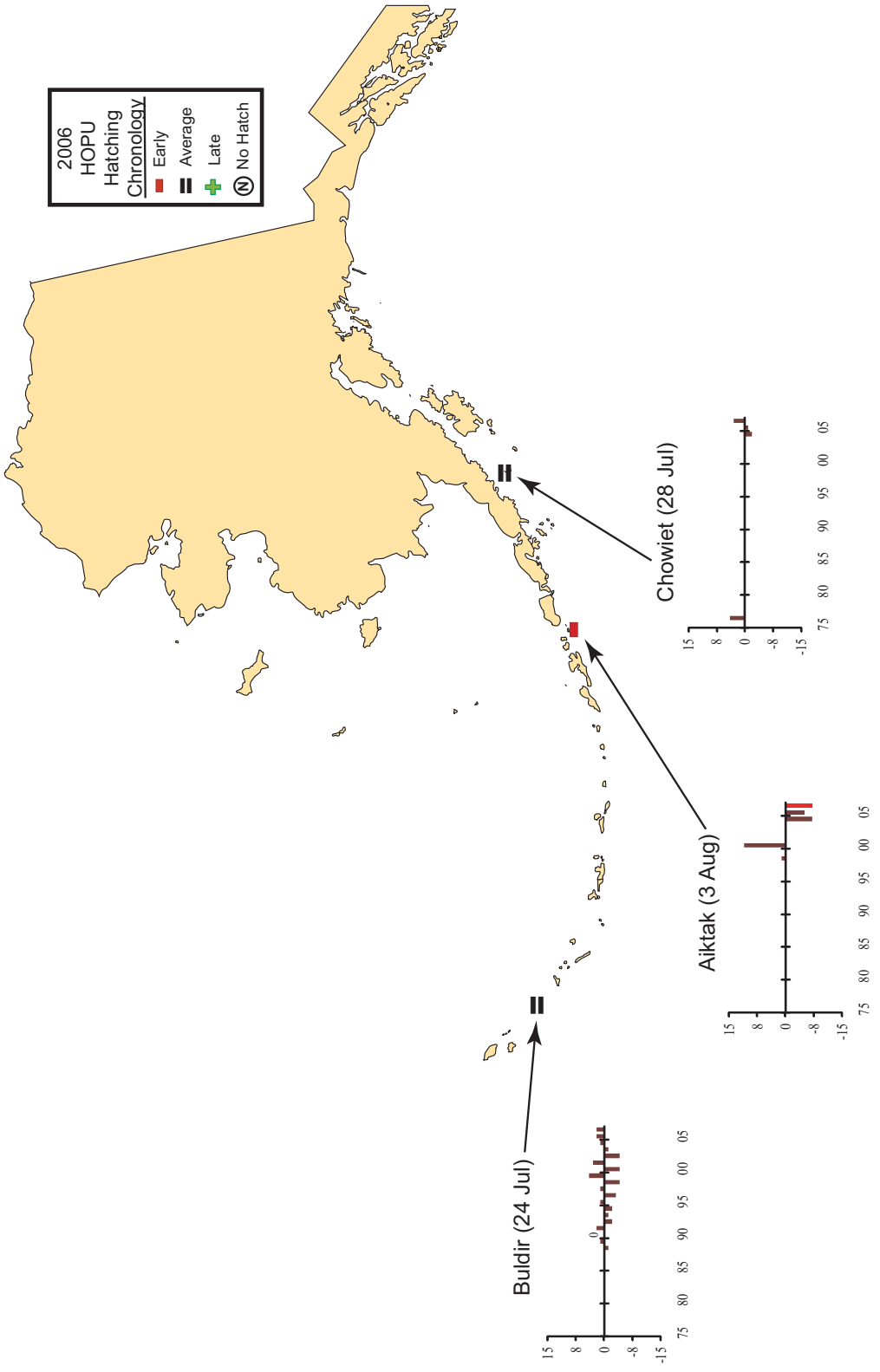


Figure 45. Hatching chronology of horned puffins at Alaskan sites monitored in 2006. Graphs indicate the departure in days (if any), from the site mean (in parentheses; current year not included).

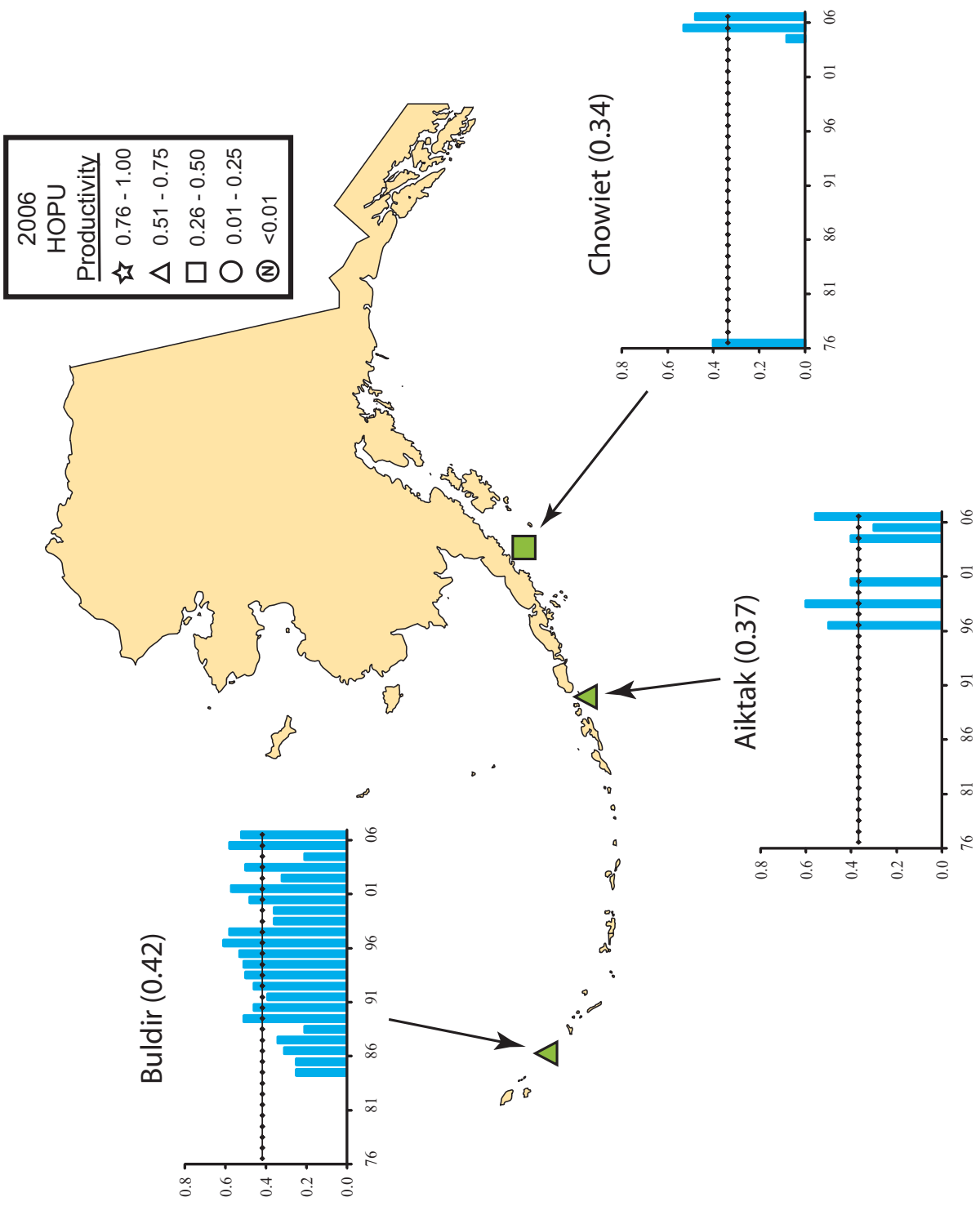


Figure 46. Productivity of horned puffins (chicks fledged/egg) at Alaskan sites monitored in 2006. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is > 20% above site mean).

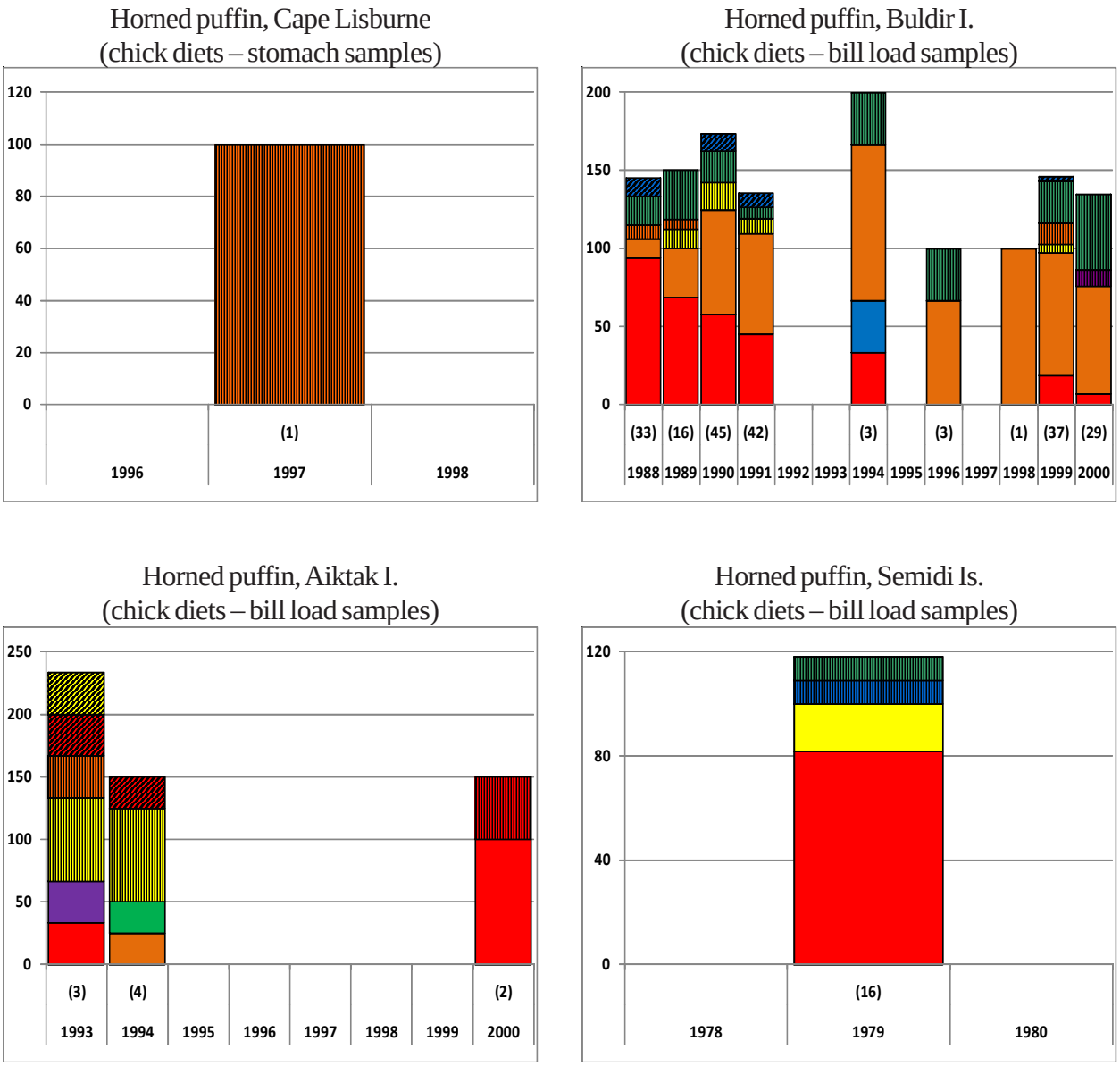


Figure 47. Diets of horned puffins at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Tufted puffin (*Fratercula cirrhata*)

Breeding chronology.–Hatch dates for tufted puffins were earlier than normal at Buldir Island, about average at Aiktak Island and late at Chowiet Island in 2006 (Table 34, Fig. 48).

Table 34. Hatching chronology of tufted puffins at Alaskan sites monitored in 2006.

Site	Median	Mean	Long-term Average	Reference
Buldir I.	4 Jul (7)[a]	6 Jul (7)	15 Jul[b] (16)[a]	Orben et al. 2006
Aiktak I.	3 Aug (12)	5 Aug (12)	4 Aug[b] (9)	Helm and Zeman 2006
Chowiet I.	21 Jul (23)	24 Jul (23)	19 Jul[b] (2)	Helm and Zeman 2007

[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 2006, tufted puffin productivity was about average at Buldir and Chowiet islands and above average at Aiktak Island (Table 35, Fig. 49).

Table 35. Reproductive performance of tufted puffins at Alaskan sites monitored in 2006.

Site	Chicks Fledged[a]/Egg	No. of Plots	Long-term Average	Reference
Buldir I.	0.39	N/A[b] (23)[c]	0.43 (18)[c]	Orben et al. 2006
Aiktak I.	0.60	N/A (73)	0.45 (10)	Helm and Zeman 2006
Chowiet I.	0.46	N/A (35)	0.44 (2)	Helm and Zeman 2007

[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 significant positive population trend for tufted puffins at Bogoslof Island (+3.0% per annum), significant negative trends at E. Amatuli and St. Lazaria islands (-3.1% and -5.9% per annum, respectively), and no trend at Aiktak Island (Fig 50).

Diet.–Diets of tufted puffins from the Barren Islands consisted entirely of small fish, with pollock being a major contributor (Fig. 51). Diet samples from Buldir Island showed a diverse diet; greenling and squid were important prey items in most years, while sand lance and pollock were significant sources of food in some years. Tufted puffins from Middleton Island ate predominately sand lance and small cephalopods. Samples from Aiktak Island showed diversity; pollock was an important contributor in most years.

Only prey that occurred in 5% or more of the 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.

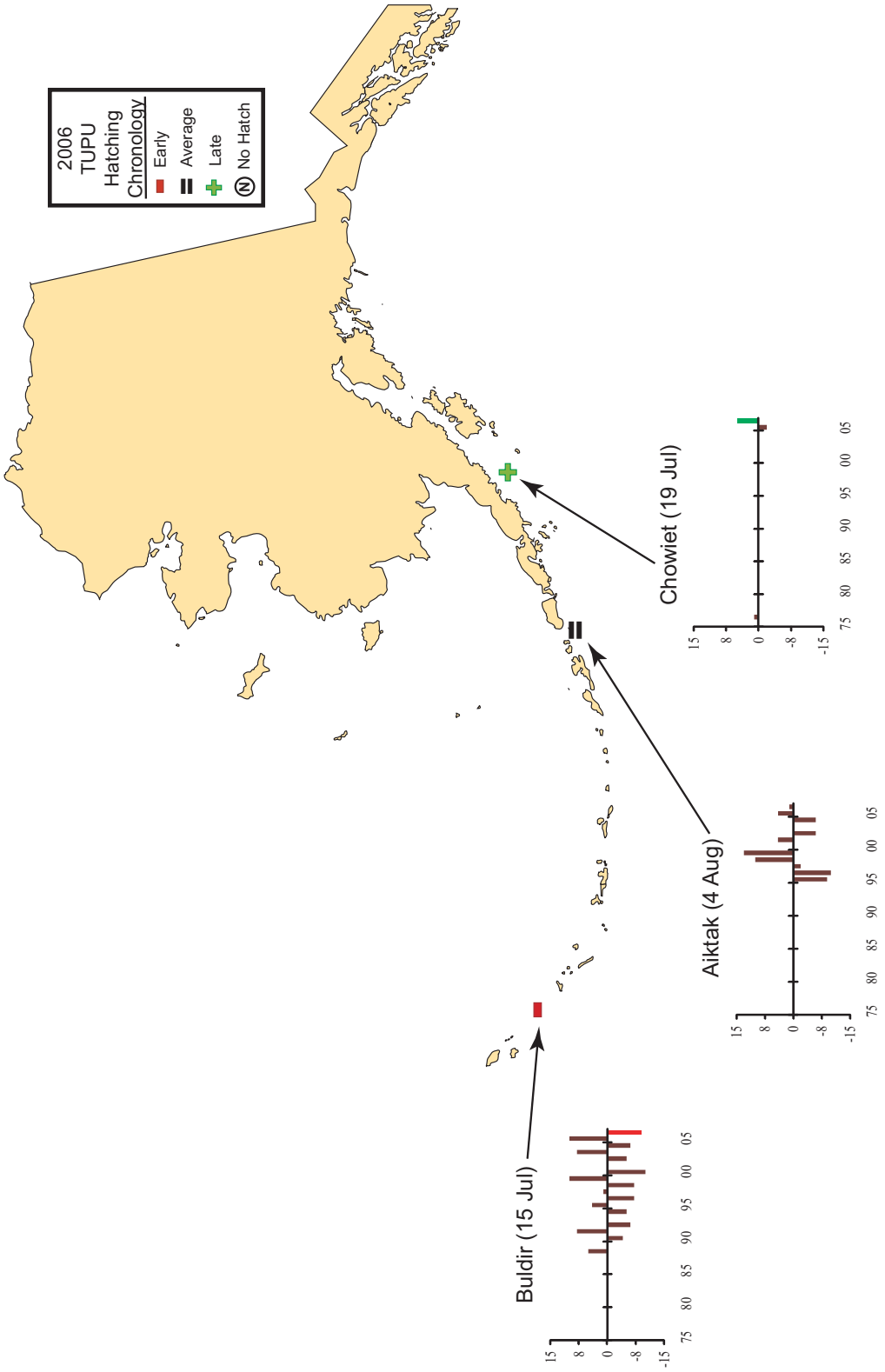


Figure 48. Hatching chronology of tufted puffins at Alaskan sites monitored in 2006. Graphs indicate the departure in days (if any), from the site mean (in parentheses; current year not included).

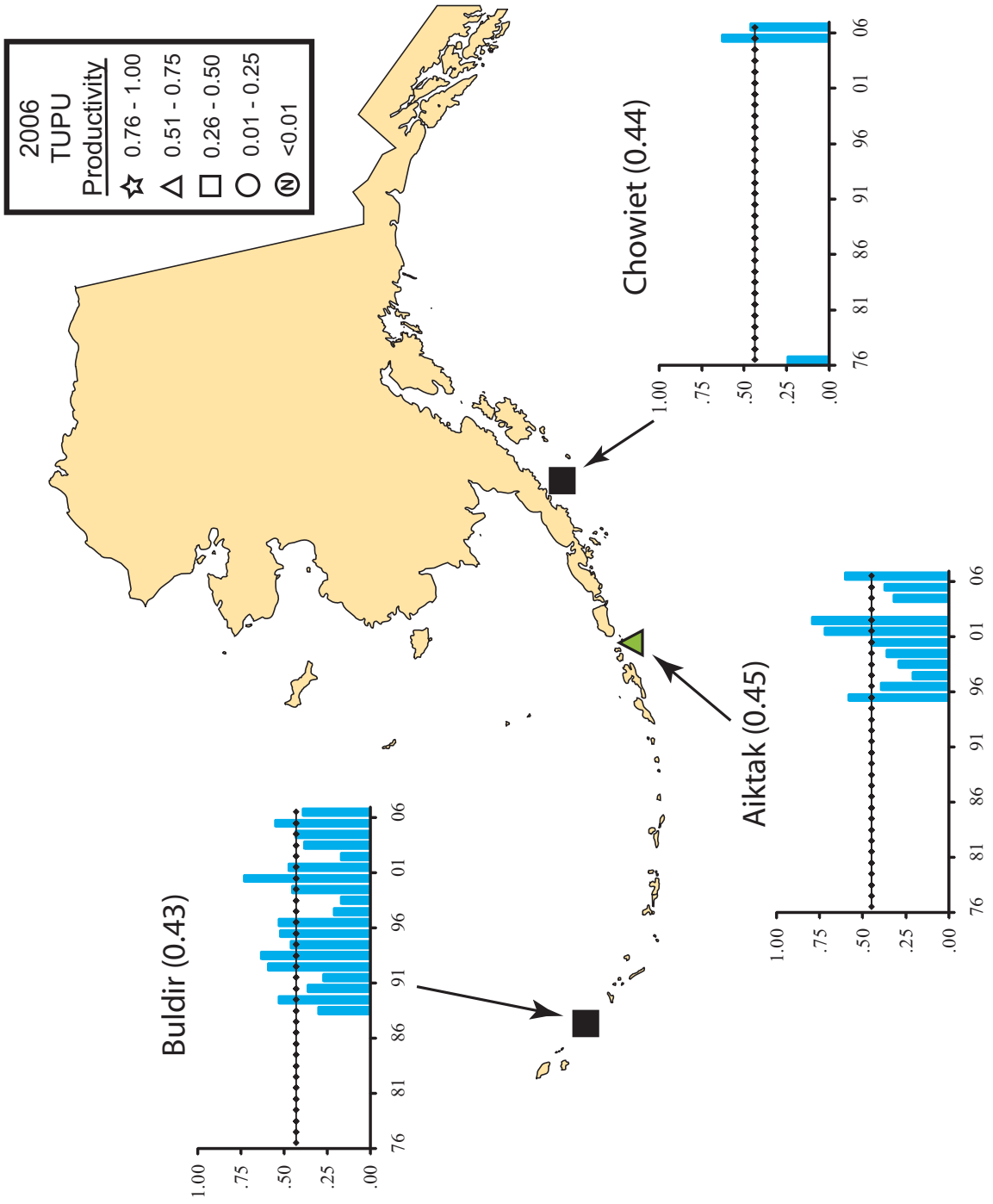


Figure 49. Productivity of tufted puffins (chicks fledged/egg) at Alaskan sites monitored in 2006. Lack of bars indicates that no data were gathered in those years. Dotted line is the mean productivity at the site (in parentheses; current year not included). Color of symbol indicates how current year's success compared to the site mean (red is >20% below, black is within 20% and green is > 20% above site mean).

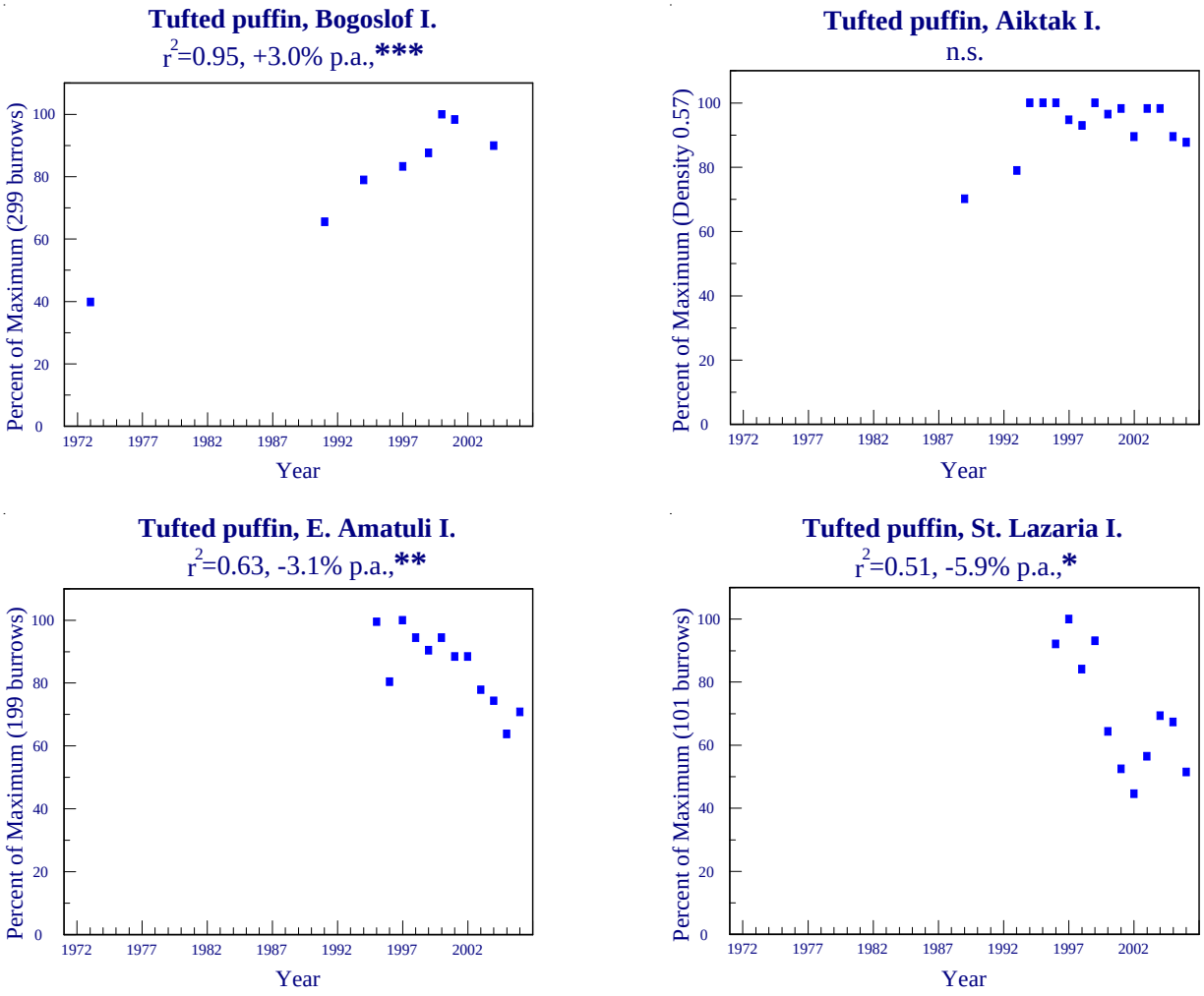


Figure 50. Trends in populations of tufted puffins at Alaskan sites. Error bars (90% confidence intervals) are shown for years with multiple counts. Significance of trends indicated as: n.s. p>= 0.05 (not significant), * p<0.05, ** p<0.01, *** p<0.001. Rates of increase or decline are reported as percent change per annum (p.a.).

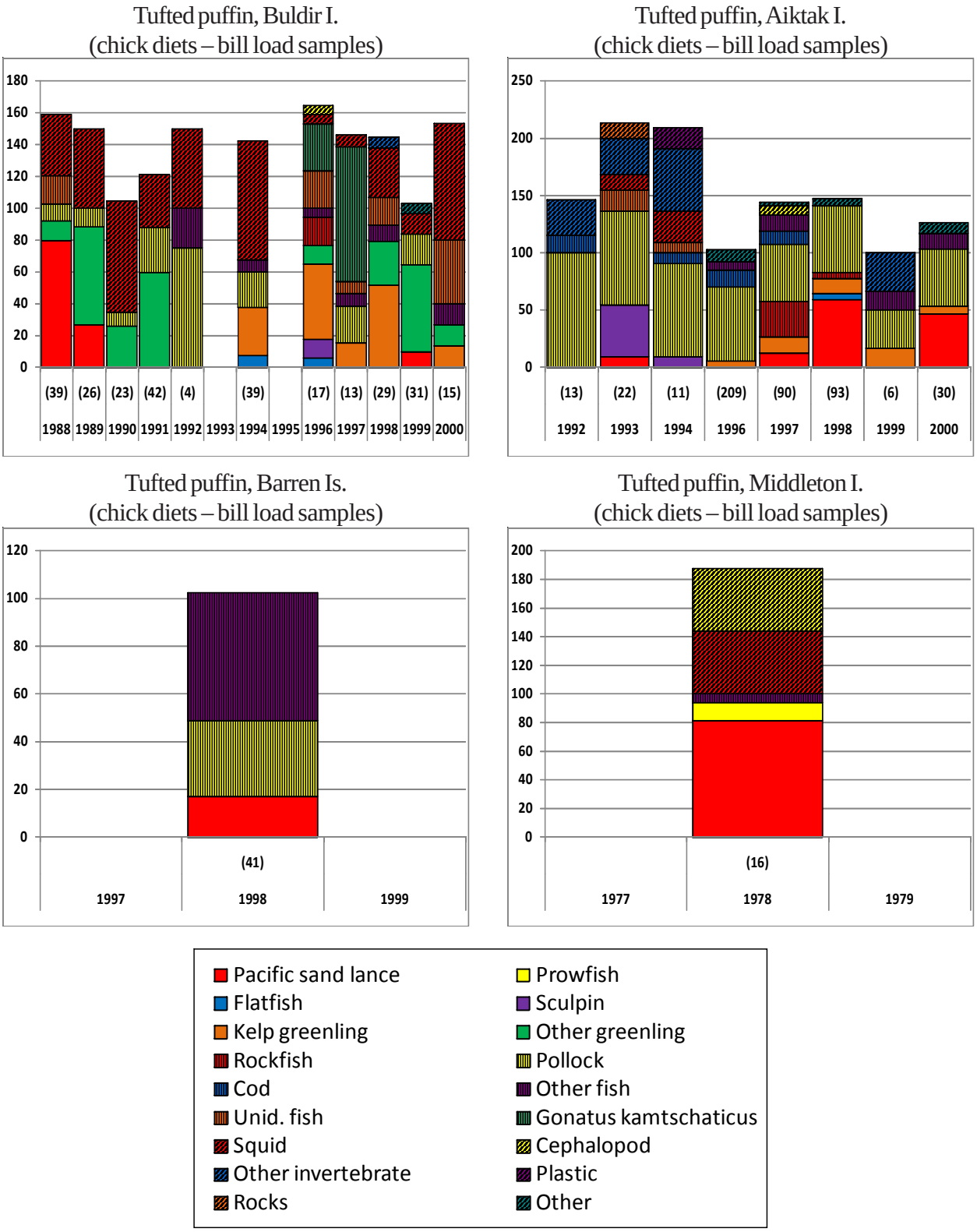


Figure 51. Diets of tufted puffins at Alaskan sites. Source of samples (adult or chick) and sample type are indicated in the graph title. Data are reported as percent occurrence of prey type in the diet. Sample sizes are reported below each bar.

Summary

Species differences

Surface plankton-feeders.–In 2006, timing of hatching was average for fork-tailed (FTSP) and Leach's storm-petrels (LHSP) at Aiktak and St. Lazaria islands (Table 36). Storm-petrels had average reproductive success at all monitored sites in 2006, except that fork-tailed storm-petrel productivity was higher than average at Kasatochi Island (Table 37). Storm-petrel (STPE) burrow counts (both species combined) have increased or remained stable in recent years (Table 38).

Surface fish-feeders.–We found no significant trends for northern fulmar (NOFU) populations at Hall, St. Paul, St. George or Chowiet islands (Table 38).

Glaucous-winged gulls (GWGU) are treated here, although they are opportunistic feeders taking other birds as well as fish for prey. In 2006, gull mean hatch date was later than average at Aiktak and St. Lazaria islands (Table 36). Gulls had below average success at Aiktak and St. Lazaria islands, above average reproduction at Buldir and average success at Chowiet Island in 2006 (Table 37). Glaucous-winged gull populations showed stable trends at three colonies, a significant decline at Buldir Island and increases at Middleton and St. Lazaria islands (Table 38).

Black-legged kittiwake (BLKI) hatch dates were earlier than normal at two of seven sites and average at the remaining locations in 2006 (Table 36). In 2006 black-legged kittiwake productivity was below average at six of the eleven monitored sites, average at one site and above average at four colonies (Table 37). Black-legged kittiwake populations exhibited stable trends at six sites, significant declines at five colonies and significant positive trends at three locations (Table 38).

Red-legged kittiwake (RLKI) hatching chronology was early at St. Paul and St. George islands and about average at Buldir Island in 2006 (Table 36). Reproductive success was below average at St. Paul Island, average at St. George Island and above average at Buldir Island in 2006 (Table 37). This species exhibited a significant negative population trend at St. Paul Island, no trend at St. George Island and a significant increase at Buldir Island (Table 38).

Diving fish-feeders (nearshore).–Timing of hatching was late for red-faced cormorants (RFCO) at St. Paul Island and pelagic cormorants (PECO) at Cape Peirce in 2006 (Table 36). Red-faced cormorants had above average reproductive success at Buldir and Ulak islands, and below average productivity elsewhere in 2006 (Table 37). Pelagic cormorant success was below average at two sites, average at two sites and above average at the remaining two colonies in 2006 (Table 37). We found a significant decline of red-faced cormorants at Chiniak Bay (Table 38). Pelagic cormorants showed no significant trends at three monitored colonies, and declining numbers at three sites. Unspecified cormorant (UNCO) populations were stable at all four monitored colonies.

Pigeon guillemot (PIGU) numbers showed a significant decline in Prince William Sound but no trends at Buldir, Kasatochi or St. Lazaria islands (Table 38).

Table 36. Seabird relative breeding chronology compared to averages for past years within regions[a]. Only sites for which there were data from 2006 are included.

Region	Site	FTSP	LHSP	RFCO	PECO	GWGU	BLKI	RLKI	COMU	TBMU	ANMU	PAAU	LEAU	WHAU	CRAU	RHAU	HOPU	TUPU
N. Bering/ Chukchi	Bluff						=		=									
SE Bering	St. Paul I.			+			–	–	+	+								
	St. George I.						–	–	+	+								
	C. Peirce				+		=		=									
	Aiktak I.	=	=			+					+						–	=
SW Bering	Buldir I.						=	=	=	=		+	=	+	+		=	–
	Kasatochi I.												+		+			
Gulf of Alaska	Chowiet I.						=		=	+		–					=	+
	E. Amatuli I.						=		+									
Southeast	St. Lazaria I.	=	=			+			+	+						=		

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

Table 37. Seabird relative productivity levels compared to averages for past years within regions[a]. Only sites for which there were data from 2006 are included.

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

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

Table 38. Seabird population trends compared within regions[a].

Region	Site	NOFU	STPE	RFCO	PECO	UNCO	GWGU	BLKI	RLKI	COMU	TBMU	UNMU	PIGU	RHAU	TUPU
N. Bering/ Chukchi	C. Lisburne							+				+			
	St. Lawrence I.									=	=				
	Bluff							=		=					
	Hall I.	=			–			–		=	=				
SE Bering	St. Paul I.	=						–	–	–	–				
	St. George I.	=						=	=	=	=				
	C. Peirce				=			–		–					
	Round I.							=		=					
	Bogoslof I.						=								+
	Aiktak I.		=			=	=					–			=
SW Bering	Agattu I							=				+			
	Alaid/Nizki Is.					=									
	Buldir I.				=		–	+	+		+		=		
	Ulak I.					=						=			
	Kasatochi I.					=	=						=		
	Koniuji I							=				+			
Gulf of Alaska	Chowiet I.	=						–				+			
	Chiniak Bay			–	–			=							
	E. Amatuli I.		=												–
	P. William Snd							+					–		
	Middleton I.				–		+	–				–			
Southeast	St. Lazaria I.		+		=		+					–	=	+	–

[a]Codes:
"–" indicates a significant ($p<0.05$) negative population trend for this site or region,
"=" indicates no significant trend($p>=0.05$)
"+" indicates a significant ($p<0.05$) positive population trend for this site or region.

Diving fish-feeders (offshore).–Timing of common murre (COMU) hatching in 2006 was average at four colonies and late at four sites (Table 36). Thick-billed murre (TBMU) chronology was later than average at four of five monitored colonies and average at Buldir Island in 2006 (Table 36).

Common and thick-billed murres exhibited average or below average reproductive success at all but two monitored sites in 2006, the exceptions being above average productivity of common murres at Round Island and thick-billed murres at Aiktak Island (Table 37).

Numbers of common murres showed significant declines at two sites and remained relatively stable at five locations (Table 38). Thick-billed murre populations exhibited a significant declining trend at one site, an increase at one colony and stable numbers at three locations. At colonies where murres were not identified to species during counts (UNMU), numbers significantly increased or remained stable at five sites and showed significant negative trends at three locations (Table 38).

Ancient murrelet (ANMU) hatching chronology was late and productivity was above average at Aiktak Island in 2006 (Tables 36 and 37).

Rhinoceros auklet (RHAU) eggs hatched at about the usual time at St. Lazaria Island in 2006 (Table 36). This species had above average productivity at St. Lazaria Island in 2006 (Table 37). We found a significant increase in the number of rhinoceros auklet burrows at St. Lazaria Island (Table 38).

Horned puffins (HOPU) exhibited normal or early hatching chronology, and higher than average productivity at the three monitored sites in 2006 (Tables 36 and 37).

Tufted puffin (TUPU) eggs hatched earlier than average at Buldir Island, late at Chowiet Island and at about the usual time at Aiktak Island in 2006 (Table 36). Reproductive success for this species was above average at Aiktak Island and average at Buldir and Chowiet islands in 2006 (Table 37). Tufted puffin populations increased at one site, declined at two colonies and remained unchanged at one location (Table 38).

Diving plankton-feeders.–Parakeet (PAAU), least (LEAU), whiskered (WHAU) and crested (CRAU) auklets had later than average nesting chronologies at most sites where they were monitored in 2006 (Table 36). With two exceptions, parakeet, least, whiskered and crested auklets had average or above average success at all monitored sites in 2006. Least and crested auklet productivity was below average at St. Lawrence Island (Table 37).

Regional differences

Northern Bering/Chukchi.–Black-legged kittiwake and common murre hatching chronology was about average at Bluff in 2006 (Table 36). Reproductive success was below average for black-legged kittiwakes at Cape Lisburne and Bluff in 2006 (Table 37). At St. Lawrence Island, common murre productivity was average whereas success was below average for thick-billed murres, and least and crested auklets. We found no trends in northern fulmar numbers at Hall Island but pelagic cormorant populations there were down significantly (Table 38). Black-legged kittiwake populations also exhibited a negative trend at Hall Island but were stable at Bluff and showed a significant positive trend at Cape Lisburne. Neither common nor thick-billed murre populations showed a significant trend at any monitored colony in this region whereas unspecified murres increased significantly at Cape Lisburne.

Southeastern Bering.–Fork-tailed and Leach's storm-petrel hatching chronology was about average in this region in 2006 (Table 36). Cormorants, glaucous-winged gulls and ancient murrelets exhibited later than average hatching chronology in this region, whereas kittiwake chronology was average or early. Timing of murre hatching was about average or late at the Pribilof Islands. Horned puffin eggs hatched earlier than normal and tufted puffin hatching chronology was about average at Aiktak Island in 2006.

Storm-petrel reproductive success was average in this region in 2006 (Table 37). Cormorants and glaucous-winged gulls experienced average or below average productivity. Kittiwakes exhibited lower than normal productivity in most instances in this region in 2006, whereas murre productivity was average or above average at most monitored colonies. Ancient murrelets and puffins exhibited above average productivity at Aiktak Island in 2006.

Northern fulmar numbers appeared to be stable at both monitored colonies in this region (Table 38). Storm-petrel populations exhibited no trends at Aiktak Island. There were no clear patterns in population trends among fish-feeders in this region: 1) neither pelagic nor unspecified cormorants showed a trend; 2) glaucous-winged gull numbers appeared to be stable at Bogoslof and Aiktak islands; 3) we found significant negative trends for black-legged kittiwakes at St. Paul Island and Cape Peirce but no trends for this species at the two other monitored sites; 4) red-legged kittiwakes exhibited a significant decline at St. Paul Island but not at St. George Island; 5) we found significant negative population trends for common murres at St. Paul Island and Cape Peirce, for thick-billed murres at St. Paul Island, and for unspecified murres at Aiktak Island. Murre numbers showed no trends at other monitored sites; 6) tufted puffin population trends were significantly positive at Bogoslof Island but no trend was evident at Aiktak Island.

Southwestern Bering.–Kittiwake and murre hatch dates were about average at Buldir Island in 2006 (Table 36). Plankton-feeders (auklets) exhibited later than average breeding chronology in five of six instances in this region in 2006. Horned puffin chronology was about average at Buldir Island, and tufted puffins exhibited early hatching chronology at that colony in 2006.

Both fork-tailed and Leach's storm-petrels exhibited average or above average productivity in this region in 2006 (Table 37). Cormorant success was average or above at all of the sites monitored in this region with the exception of below average productivity of red-faced cormorants at Kasatochi Island. Glaucous-winged gull productivity was above average at Buldir Island. Both black- and red-legged kittiwakes experienced above average production at Buldir Island in 2006. Common and thick-billed murre productivity was about average at Buldir Island. Auklets exhibited average or above average productivity at monitored southwestern Bering Sea colonies in 2006. Horned puffins had above average productivity at Buldir Island in 2006 and tufted puffin success was about average there.

We found no significant trends in cormorant populations in this region (Table 38). Glaucous-winged gulls showed a significant negative population trend at Buldir Island and no trend at Kasatochi Island. Both black- and red-legged kittiwakes increased significantly at Buldir Island but the former species exhibited no trend at Agattu or Koniuji islands. Murres were either stable or increasing in this region and pigeon guillemots exhibited no trends.

Northern Gulf of Alaska.–Breeding chronology was normal for black-legged kittiwakes breeding in this region in 2006 (Table 36). Murres exhibited average or late hatching chronology at Chowiet and East Amatuli islands. Parakeet auklets were early, horned puffin chronology was normal and tufted puffins were late at Chowiet Island in 2006.

Productivity was average or above average for most species monitored in this region in 2006, the exception being below average success for black-legged kittiwakes in Prince William Sound (Table 37).

Northern fulmars showed no trend in populations at Chowiet Island (Table 38). The same can be said for storm-petrels at East Amatuli Island. We found a significant decline of both red-faced and pelagic cormorants at Chiniak Bay, and of pelagic cormorants at Middleton Island. Glaucous-winged gulls increased at Middleton Island. Black-legged kittiwake numbers were significantly down at Chowiet and Middleton islands, up in Prince William Sound and stable at Chiniak Bay. We found a significant positive trend for murre populations at Chowiet Island and a decline for murres at Middleton Island. Pigeon guillemot populations declined in Prince William Sound, as did tufted puffin numbers at East Amatuli Island.

Southeast Alaska.–Fork-tailed and Leach's storm-petrels exhibited average nesting chronology at St. Lazaria Island in 2006 (Table 36). Hatch dates were late for glaucous-winged gulls and murres, and about average for rhinoceros auklets at St. Lazaria Island.

Leach's storm-petrels, pelagic cormorants and glaucous-winged gulls all exhibited below average success in this region in 2006, whereas fork-tailed storm-petrels and murres had average productivity (Table 37). Rhinoceros auklet reproduction was above average at St. Lazaria in 2006.

Storm-petrel, glaucous-winged gull and rhinoceros auklet numbers increased significantly at St. Lazaria Island (Table 38). Pelagic cormorant and pigeon guillemot populations were stable but murre and tufted puffin numbers showed a significant negative trend at this colony.

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Appendix 1. Masses of prey items used to estimate biomass for planktivore diet graphs (see Figs. 35, 38, 39 and 42).

		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. 35, 38, 39 and 42).

		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. 35, 38, 39 and 42).

	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