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BREEDING SUCCESS AND POPULATION TRENDS OF SELECTED SEABIRDS IN ALASKA IN 1996

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EXECUTIVE SUMMARY

Information is being collected annually for selected species of marine birds at breeding colonies to monitor the condition of the marine ecosystems surrounding the far-flung Alaska Maritime NWR. The strategy for colony monitoring includes estimating reproductive success (e.g., chicks per nest) and population trends of representative species of various foraging guilds (e.g., murres are off-shore diving fish-eaters, kittiwakes are offshore surface-feeding fish-eaters, auklets are diving plankton-eaters) at geographically-dispersed breeding sites. This information enables managers to better understand ecosystem processes and respond appropriately to resource issues. The value of the marine bird monitoring program is enhanced by having sufficiently long time-series to describe patterns for these long-lived species.

In previous years we have written reports for each monitoring site, and that was adequate when there were only a few sites. Now, however, data are being gathered annually at more sites on the Alaska Maritime NWR, on other refuges, and non-refuge land in conjunction with several research projects (e.g., Exxon Valdez Oilspill Trustee Council). As a result of the increased amount of information, we decided to report an annual overview of monitoring results, beginning in 1996, from all refuge sites. Several other Service projects that are collecting similar data kindly contributed their information for this report. The report is patterned after a similar product for Britain and Ireland produced by the Joint Nature Conservation Committee.

In summer 1996 data were gathered on fulmars, cormorants, gulls, kittiwakes, murres, auklets, and/or puffins at 9 annual monitoring sites on the Alaska Maritime NWR and 1 annual monitoring site on Togiak NWR. In addition, data were gathered at 6 other locations which are visited intermittently or are currently part of an intensive research program off refuges (e.g., Prince William Sound).

Storm-petrels and auklets apparently had adequate plankton at the surface and within the water column, respectively, to fuel above average reproduction in 1996 in all regions where they were monitored. The forage fish-feeders did not fare as well overall. Diving offshore fish-feeders like murres and puffins generally had average success, except productivity was below average for murres at 2 sites in the southeastern Bering Sea. Success rates of surface fish-feeders like gulls and kittiwakes, generally the most sensitive species to fluctuations in abundance or distribution of prey, varied among regions. There was a nearly complete reproductive failure for black-legged kittiwakes in the eastern Chukchi Sea (Cape Lisburne) and success was also low at sites in the southeastern Bering Sea. Conditions apparently were closer to average for kittiwakes in the SW Bering Sea and in Southeast Alaska. The N. Gulf of Alaska, except for Chisik I. where kittiwakes tend to fail frequently, apparently was particularly productive for kittiwakes and gulls in 1996.

Population trends are presented for sites and species for which surveys were conducted in 1996. Most of the relatively-long time-series are for fish-eating species, but we are beginning to accumulate population data on plankton-feeders as well, and in the next few years comparison will be possible.

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INTRODUCTION

This report is the first in a planned series of annual reports summarizing the results of seabird monitoring surveys at breeding colonies on the Alaska Maritime National Wildlife Refuge (NWR) and elsewhere in Alaska. This report series is patterned after the publications of the Joint Nature Conservation Committee in Britain (e.g., Thompson et al. 1997). Like the British seabird monitoring program, the one in Alaska is designed to keep track of selected species of seabirds that indicate changes in the marine 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" (Alaska National Interests Land Conservation Act of 1982), and the monitoring program is an integral part of the management of this refuge. 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 (national and state refuges) and on private lands as well. The strategy for colony monitoring includes estimating reproductive success and population trends of representative species of various foraging guilds (e.g., murres are off-shore diving fish-eaters, kittiwakes are offshore surface-feeding fish-eaters, auklets are diving plankton-feeders, etc.) at geographically dispersed breeding sites along the entire coastline of Alaska. About 12 sites (Fig. 1), located roughly 300-500 km apart, are scheduled for annual surveys, although data were available for only 10 of these in 1996. In addition, colonies near the annual sites are identified for less frequent surveys to "calibrate" the information at the annual sites. Furthermore, other research projects (e.g., like those associated with evaluating the impacts of oil spills on marine birds) supplement the monitoring data base.

In this report, we summarize information from 1996 for each species; i.e., tables with estimates of reproductive success and maps with symbols indicating the relative success at various sites. In addition, historical patterns are illustrated for most annual monitoring sites on the Alaska Maritime NWR (those where we have information). Population trend information also is included for sites where data were gathered in 1996.

METHODS

Generally methods were used like those specified in "Standard Operating Procedures for Population Inventories" (USFWS 1997*a*, *b*, *c*). At most annual sites, estimates of reproductive success were based on periodic checks of a sample of nests (usually in plots) throughout the breeding season. A few of the estimates were based on single visits to colonies late in the breeding season to record chicks per nest. We expressed productivity in terms of chick fledged per nest or chick fledged per egg when this variable was available, but occasionally other variables (e.g., chicks hatched per egg) were compared. Population surveys were conducted for ledge-nesting species at times of the day and breeding season when variability in attendance was reduced.

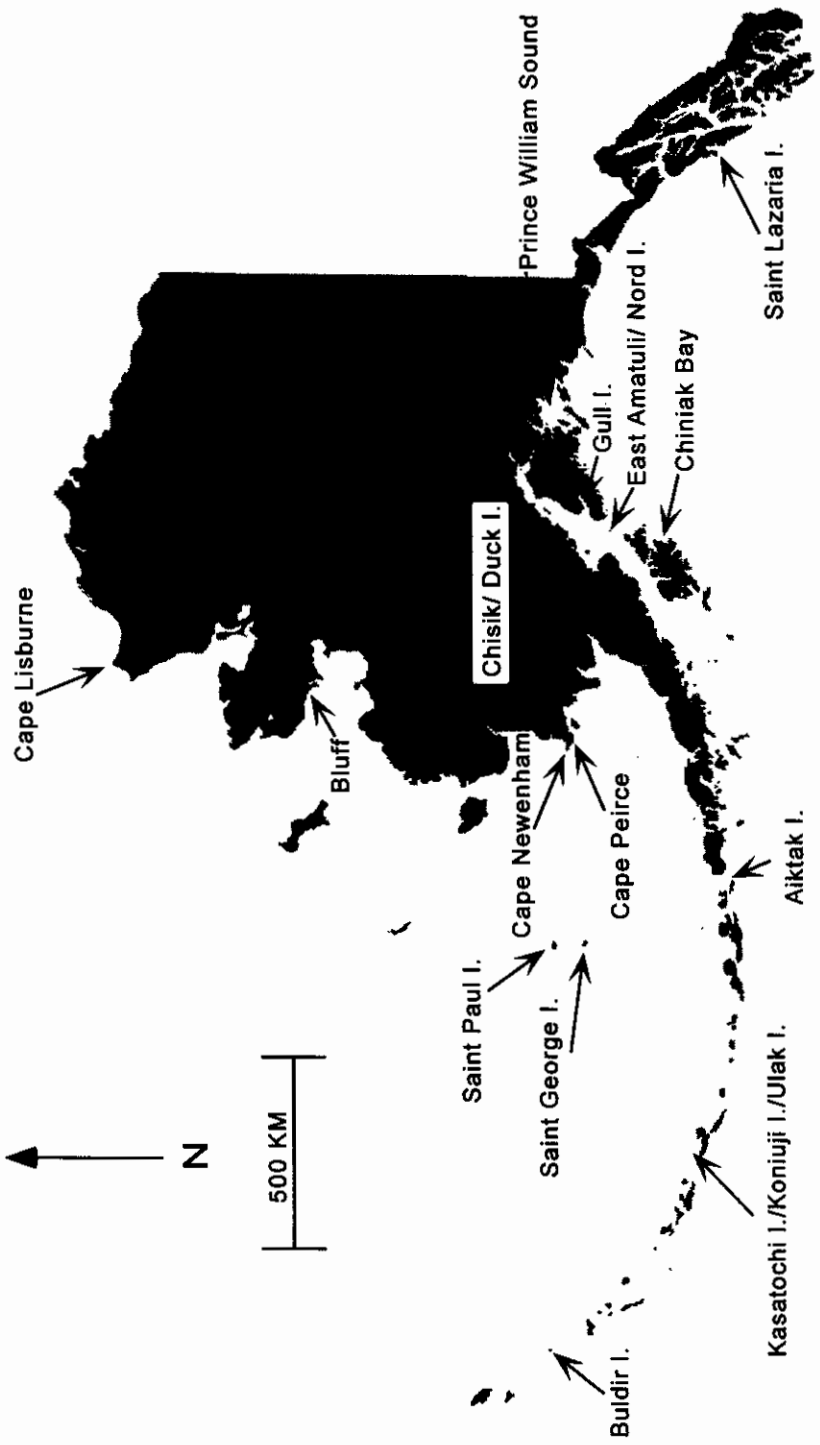


Figure 1. Map of Alaska showing the locations of seabird monitoring sites summarized in this report.

RESULTS

Northern Fulmar (*Fulmarus glacialis*)

Productivity.--No information was obtained on productivity of northern fulmars in 1996.

Populations.--We counted fulmars at St. Paul and St. George Islands in the Pribilofs in 1996 on plots that have been monitored since 1976 (Fig 2). It appears numbers of birds have increased since the mid-1970s on both islands, but particularly at St. Paul. Nevertheless, attendance is highly variable (note large confidence intervals on Fig. 2) so relatively large changes would have to occur before significant differences can be detected.

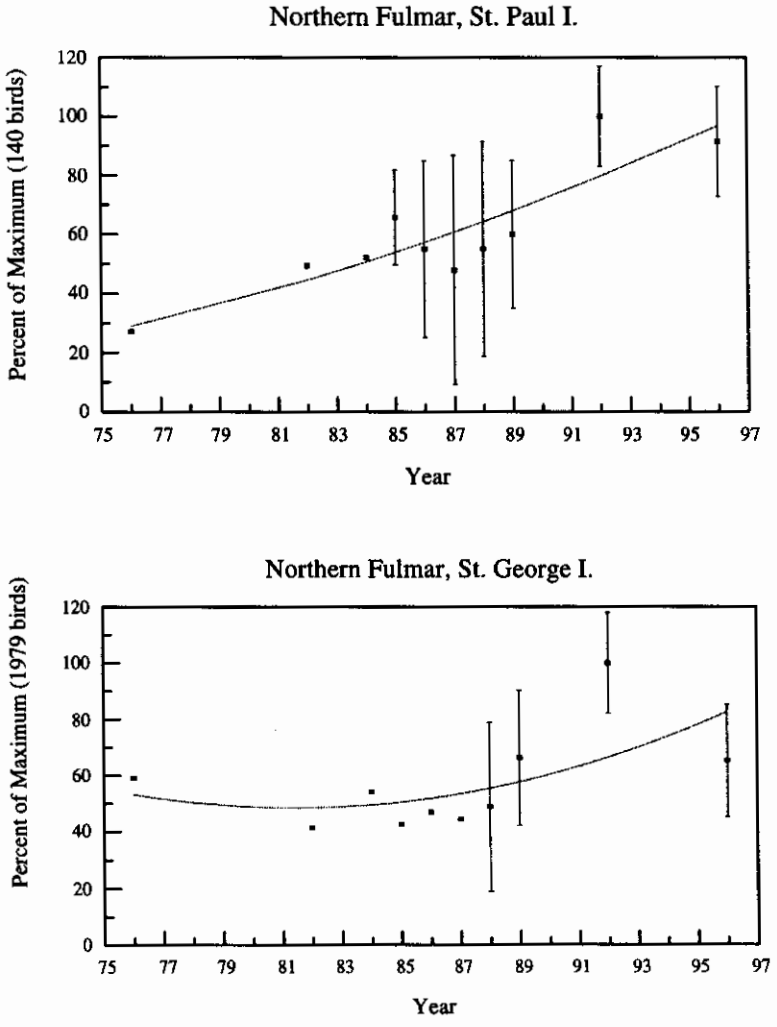


Figure 2. Trends in populations of northern fulmars at sites monitored in 1996. Error bars are 90% confidence intervals.

Fork-tailed (*Oceanodroma furcata*) and Leach's (*O. leucorhoa*) Storm-Petrels

Productivity.--In 1996, productivity of fork-tailed and Leach's storm-petrels ranged from over 80% at Buldir to around 60% at Aiktak (Table 1, Figs. 3 and 4). We only recently began recording productivity of storm-petrels at most sites, and no long-term averages are available. Nevertheless, available data from elsewhere in Alaska (e.g., Quinlan 1979, Boersma et al. 1980, Nishimoto and Byrd 1993) suggest 1996 was a year of particularly high productivity.

Table 1. Reproductive performance of storm-petrels at Alaskan sites monitored in 1996.

Site/Species	Chicks fledged/egg	No. of Plots	No. of Burrows	Reference
Fork-tailed				
Buldir I.	0.87 (0.09)[a]	8	147	Williams et al. 1997
Ulak I.	0.79 (0.07)	1	38	Scharf et al. 1996
Aiktak I.	0.63 (0.08)	11	27	Woodward 1997
Saint Lazaria I.	0.77 (0.04)	8	175	Slater et al. 1997
Leach's				
Buldir I.	0.84 (0.12)	8	156	Williams et al. 1997
Aiktak I.	0.61 (0.07)	13	67	Woodward 1997
Saint Lazaria I.	0.81 (0.04)	8	95	Slater et al. 1997

[a]Standard deviation in parentheses

Populations.--Too few years of data are available for most sites to estimate trends in nesting populations, but plots are in place to be able to do so in the future at the following annual monitoring sites: St. Lazaria, East Amatuli (fork-tailed only), Aiktak, Kasatochi/Konijui/Ulak, and Buldir. In addition, storm-petrel monitoring plots were checked at less frequently monitored sites in southeastern Alaska (i.e., Forrester Is., Slater 1997), and new plots were established in the eastern Aleutians (Kaligagan Is., Egg I., and the Baby Is., Byrd and Williams 1996).

Figure 3. Productivity of fork-tailed storm-petrels (chicks/egg) at Alaskan sites monitored in 1996.

Figure 4. Productivity of Leach's storm-petrels (chicks/egg) at Alaskan sites monitored in 1996.

Pelagic Cormorant (*Phalacrocorax pelagicus*)

Productivity.--Generally, the index to productivity for cormorants is obtained by single visits to nesting colonies late in the chick-rearing period when chicks are clearly visible. The parameter, "large chick per nest" is used to describe productivity rates. Productivity varied substantially among sites in 1996 ranging from failure at Aiktak and near-failure at Bluff to very high success at St. Lazaria (2.2 chicks $nest^{-1}$) and Kasatochi (1.8 chicks $nest^{-1}$) (Table 2, Fig. 5). The only Alaska Maritime NWR site for which we have time-series data is Buldir, where the average for 7 years between 1974 and 1996 was 1.2 ± 0.3 chicks per nest (Williams et al. 1997). There also is a multi-year data set for Cape Peirce on Togiak NWR where the average of 10 years of data between 1986 and 1996 was 1.8 ± 0.4 chicks per nest (Haggblom 1996). For Buldir and Cape Peirce, productivity was slightly lower than average in 1996.

Table 2. Reproductive performance of pelagic cormorants at Alaskan sites monitored in 1996.

Site	Large Chicks/Nest	No. of Plots	No. of Nests	Reference
Bluff	Poor			Murphy Pers. Com.[a]
Cape Peirce	1.41	7	76	Haggblom 1996
Buldir I.	1.00	1	22	Williams et al. 1997
Kasatochi I.	1.80	1	21	Scharf et al. 1996
Aiktak I.	0.00[b]	1	6	Woodward 1997
Chiniak Bay	0.70	1	154	Irons Pers. Com.[c]
Gull I.	1.59 (0.14)[d]	1	87	Zador et al. 1996
Saint Lazaria I.	2.20 (0.80)	1	10	Slater et al. 1997

[a]Murphy, E. C., University of Alaska Fairbanks, Personal Communication, 1996
[b]Post-hatch abandonment of nests occurred at this site in 1996
[c]Irons, D. B., U. S. Fish and Wildlife Service, Personal Communication, 1997
[d]Standard deviation in parentheses

Populations.--Cormorants are notorious for shifting nesting locations between years, so it is difficult to confidently interpret changes in counts. Nevertheless, numbers of pelagic cormorant nests (the index that has been used) have declined at Buldir between the mid-1970s and 1996 (Williams et al. 1997). At Cape Peirce numbers have varied since 1990 but with no obvious trend (Haggblom 1996).

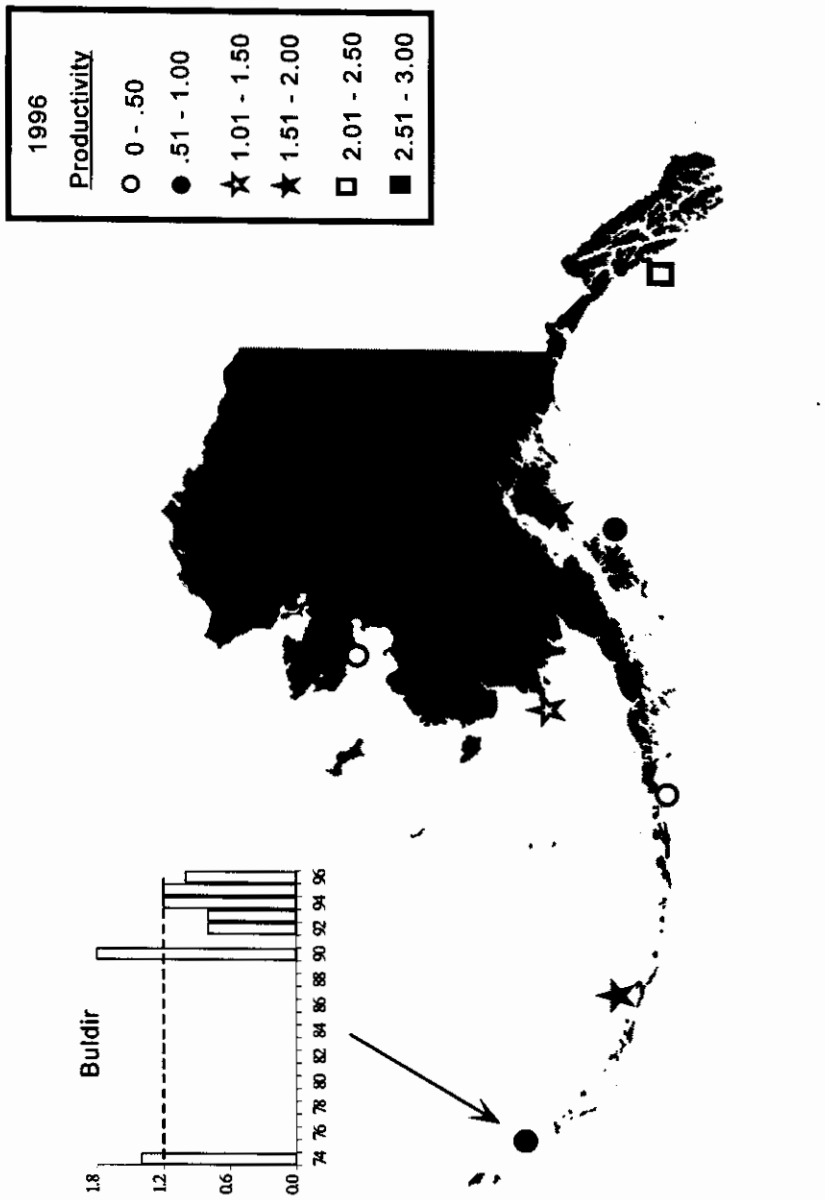


Figure 5. Productivity of pelagic cormorants (large chicks/nest) at Alaskan sites monitored in 1996. Lack of bars on graphs indicates that no data were gathered in those years. Dashed line is the mean productivity at the site in all years for which there are data.

Red-faced Cormorant (*Phalocrocorax urile*)

Productivity.--In 1996, we recorded productivity indices for only four locations. The small population at Gull I. had a very high rate of success (2.8 chicks nest^{-1}). Red-faced cormorants at St. Paul and Kasatochi had moderately high rates of productivity (1.6 and 1.1 chicks nest^{-1}, respectively), but cormorants had lower success (0.4 chicks nest^{-1}) at Chiniak Bay, Kodiak (Table 3, Fig. 6).

Table 3. Reproductive performance of red-faced cormorants at Alaskan sites monitored in 1996.

Site	Large Chicks/Nest	No. of Plots	No. of Nests	Reference
Saint Paul I.	1.56 (0.65)[a]	3	50	Climo 1997
Kasatochi I.	1.10	1	14	Scharf et al. 1996
Chiniak Bay	0.41	1	44	Irons Pers. Com.[b]
Gull I.	2.75 (1.11)	1	4	Zador et al. 1996

[a]Standard deviation in parentheses
[b]Irons, D. B., U. S. Fish and Wildlife Service, Personal Communication, 1997

Populations.--As for pelagic cormorants, shifting among sites occurs in red-faced cormorants. We normally count red-faced cormorants on plots at St. Paul, and the species is surveyed from small boats around the peripheries of Kasatochi/Koniuji/Ulak and Aiktak. Surveys have started only recently at the latter two locations, and data from St. Paul do not reflect definite trends (A. L. Sowls, unpubl. data).

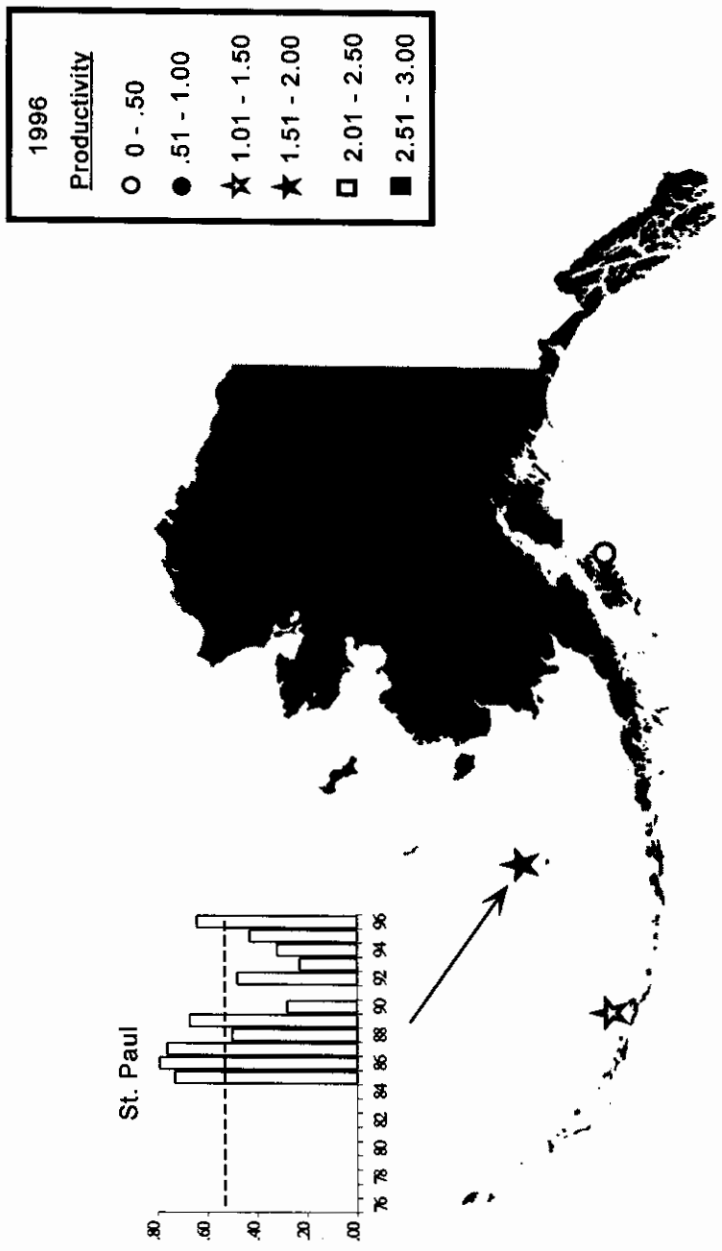


Figure 6. Productivity of red-faced cormorants (large chicks/nest) at Alaskan sites monitored in 1996. Lack of bars on graphs indicates that no data were gathered in those years. Dashed line is the mean productivity at the site in all years for which there are data.

Glaucous-winged Gull *(Larus glaucescens)*

Productivity.--Information was gathered on clutch size and/or hatch success of gulls at five sites in 1996. Gulls laid from 2.2 to 2.5 eggs per nest at Buldir, Aiktak, and Gull islands, but clutches were smaller at St. Lazaria (1.4) (Table 4). Approximately 70% of the eggs hatched at all Aiktak, Gull, and Chisik, but low hatching success was recorded at Buldir (Table 4, Fig. 7).

Table 4. Reproductive performance of glaucous-winged gulls at Alaskan sites monitored in 1996.

Site	Mean Clutch Size	Hatching Success	No. of Plots	No. of Nests	Reference
Buldir I.	2.52 (0.67)[a]	0.24 (0.01)	1	175	Williams et al. 1997
Aiktak I.	2.22 (0.88)	0.71 (0.06)	4	98	Woodward 1997
Gull I.	2.37 (0.08)	0.68 (0.03)	5	124	Zador et al. 1996
Chisik I./Duck I.		0.74 (0.01)	1	32	Zador et al. 1996
Saint Lazaria I.	2.34 (0.77)	0.59	5	53	Slater et al. 1997

[a]Standard deviation in parentheses

Populations.--We only recently began monitoring populations of glaucous-winged gulls. For the past 2-3 years they have been counted in study areas at St. Lazaria, East Amatuli, Aiktak, Buldir, and Cape Lisburne. It is too soon to estimate trends, but we will be able to track populations in the future.

Figure 7. Productivity of glaucous-winged gulls (hatching success) at Alaskan sites monitored in 1996.

Black-legged Kittiwake (*Rissa tridactyla*)

Productivity.--Data were gathered at 14 sites in 1996 (Table 5). In the Bering Sea and Chukchi Sea regions, reproductive success was relatively-low ($\leq$ 0.15 chicks nest^{-1}) and 1996 was below the long-term average at most sites (Fig. 8). Bluff (0.48 chicks nest^{-1}) was an exception to this regional pattern. In contrast, success rates were higher (0.29-0.87) in the central Gulf of Alaska, except at Chisik/Duck in upper Cook Inlet (Table 5, Fig. 8).

Table 5. Reproductive performance of black-legged kittiwakes at Alaskan sites monitored in 1996.

Site	Chicks Fledged/Nest	No. of Plots	No. of Nests	Reference
Cape Lisburne	0.00	8	195	Roseneau et al. 1997*a*
Bluff	0.48 (0.05)[a]	5	165	Murphy 1996
Saint Paul I.	0.09 (0.10)	10	280	Climo 1997
Saint George I.	0.12 (0.21)	4	95	Dragoo 1997
Cape Newenham	0.00	4	104	Haggblom 1996
Cape Peirce	0.00	10	134	Haggblom 1996
Buldir I.	0.15 (0.02)	16	426	Williams et al. 1997
Koniuji I.	0.58 (0.14)	9	313	Scharf et al. 1997
Chiniak Bay	0.29	whole area	7300	Irons Pers. Com.[b]
Nord I.	0.87	10	475	Roseneau Pers. Com.[c]
East Amatuli I.	0.71 (0.19)	11	312	Roseneau et al. 1997*b*
Gull I.	0.87 (0.10)	10	220	Zador et al. 1996
Chisik I./Duck I.	0.05 (0.03)	9	111	Zador et al. 1996
Prince William Sound	0.35	whole area	21,488	Irons Pers. Com.[a]

[a]Standard deviation in parentheses
[b]Irons, D. B., U. S. Fish and Wildlife Service, Personal Communication, 1997
[c]Roseneau, D. G., U. S. Fish and Wildlife Service, Personal Communication, 1997

Populations.--In 1996 black-legged kittiwakes were counted on monitoring plots in the Chukchi Sea (Cape Lisburne), the eastern Bering Sea (St. Paul, St. George, Cape Peirce), the Aleutians (Buldir, Koniuji), and the northern Gulf of Alaska (Chisik, Gull, E. Amatuli, Prince William Sound, and Chiniak Bay on Kodiak). We were able to describe trends at most of these sites (Fig. 9). At Cape Lisburne in the Chukchi Sea, kittiwake populations have either remained fairly level or increased slightly, depending upon the set of plots used for comparison (Roseneau et al. 1997*a*). In the eastern Bering Sea, numbers of kittiwakes may have declined at Cape Peirce on the mainland coast since the mid-1980, however high variability among years precludes drawing strong conclusions. Farther off shore in the Pribilof Islands (St. Paul and St. George), numbers appear to be stabilizing (or slightly increasing at St. George) following steep declines between the mid-1970s and the mid 1980s. In contrast, black-legged kittiwakes have increased in the western Bering Sea (Buldir) since the mid-1970s; counts in 1996 being the highest since we started monitoring at Buldir. Numbers of black-legged kittiwakes in the Gulf of Alaska apparently have remained relatively stable in Prince William Sound since 1984, although there have been changes in individual colonies (D.B. Irons, pers. comm.). At Chiniak Bay near Kodiak, kittiwakes have increased since the late 1970s but remained stable since about 1990 (D.B. Irons, pers. comm.).

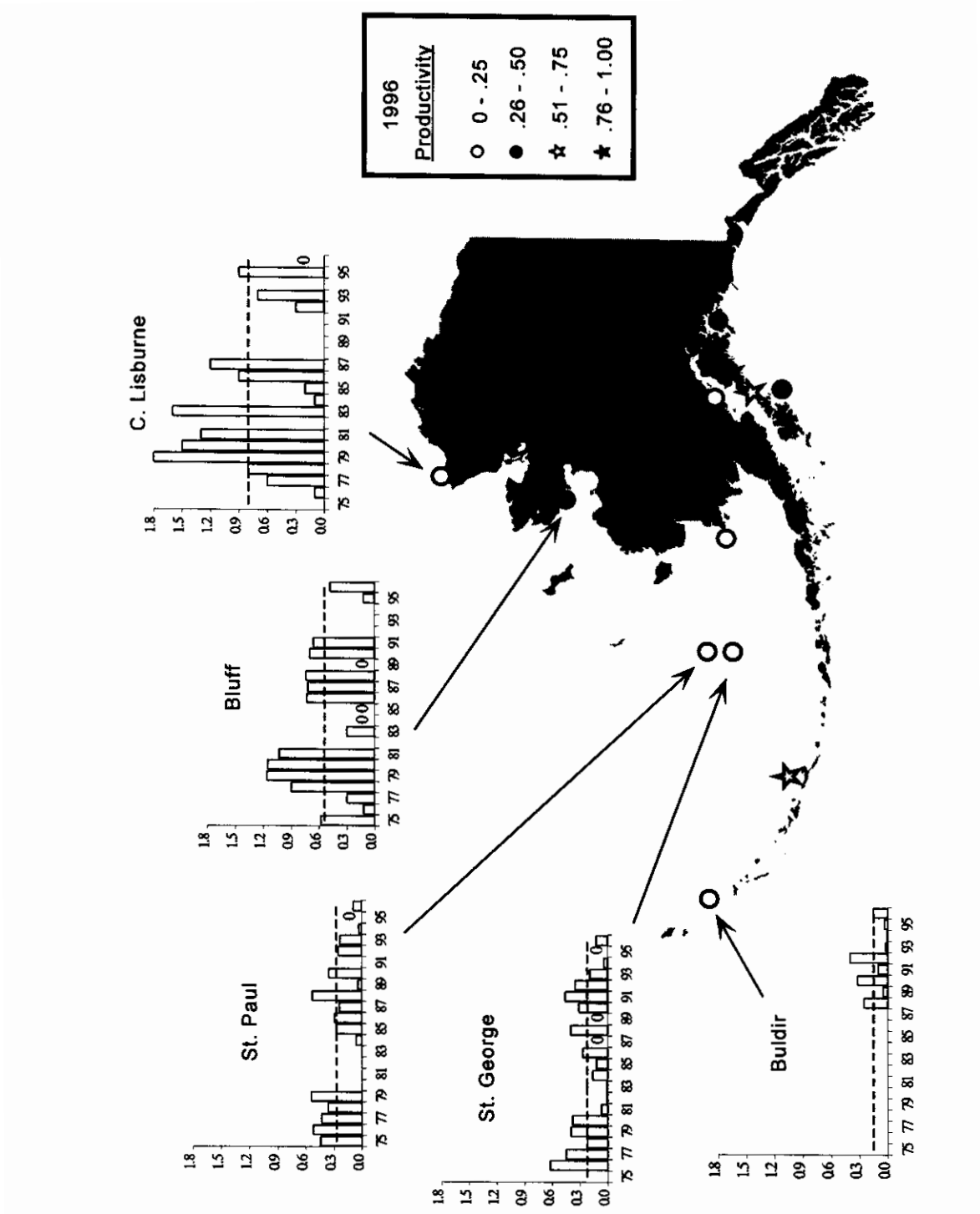


Figure 8. Productivity of black-legged kittiwakes (chicks fledged/nest) at Alaskan sites monitored in 1996. Lack of bars on graphs indicates that no data were gathered in those years. Dashed line is the mean productivity at the site in all years for which there are data.

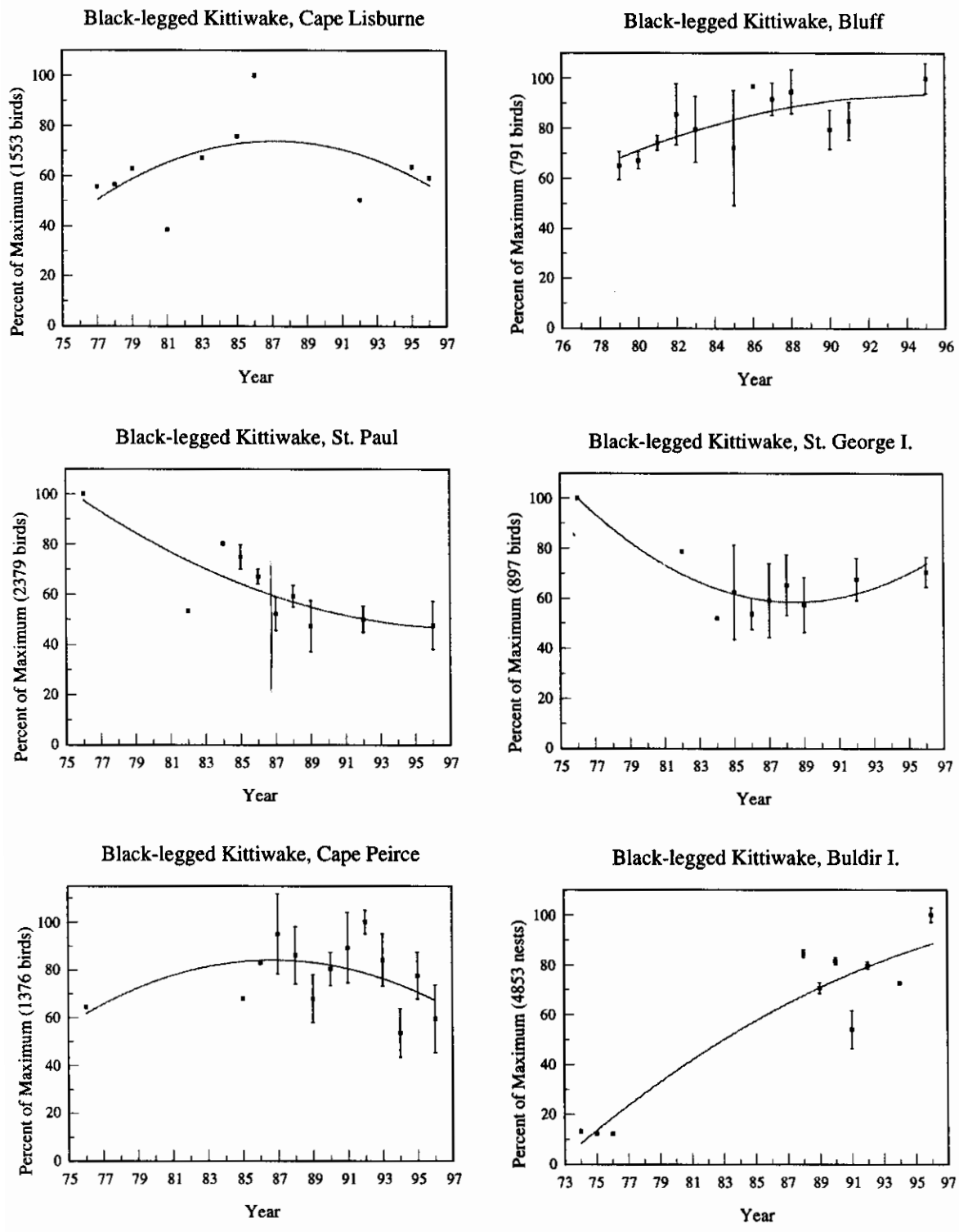


Figure 9. Trends in populations of black-legged kittiwakes at sites monitored in 1996. Error bars (90% confidence intervals) are shown for years with multiple counts.

Red-legged Kittiwake (*Rissa brevirostris*)

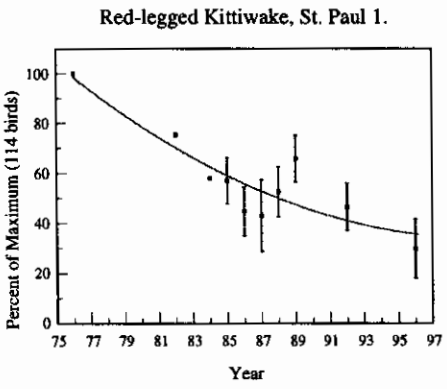
Productivity.-- In 1996, red-legged kittiwakes experienced reproductive failure at St. Paul, and only 12%-15% of the pairs produced chicks at St. George and at Buldir (Table 6). Values are below average at all sites. Rates of success in 1996 were similar to those of black-legged kittiwakes at all three sites where both species were monitored (Tables 5 and 6).

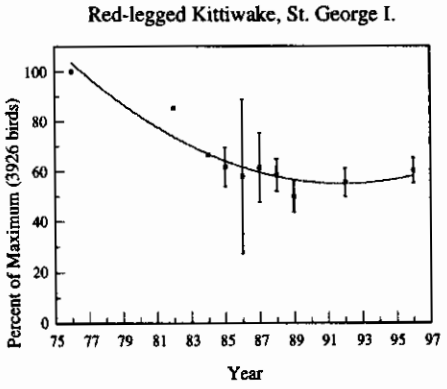
Table 6. Reproductive performance of red-legged kittiwakes at Alaskan sites monitored in 1996.

Site	Chicks Fledged/Nest	No. of Plots	No. of Nests	Reference
Saint Paul I.	0.00	2	32	Climo 1997
Saint George I.	0.12 (0.19)[a]	9	218	Dragoo 1997
Buldir I.	0.15 (0.03)	10	206	Williams et al. 1997

[a]Standard deviation in parentheses

Populations.--Red-legged kittiwakes were counted at St. Paul, St. George, and Buldir in 1996 (Fig. 10). Numbers in the Pribilofs (St. Paul and St. George) have stabilized at levels much lower than in the mid-1970s. In contrast, numbers seem to have stabilized at Buldir at a higher level than in the mid-1970s. As with black-legged kittiwakes (Fig. 9), the count of red-legged kittiwakes at Buldir in 1996 was the highest on record. In 1996, we discovered a few red-legged kittiwakes (3 nests, 13 birds) breeding at Koniuji, a new site for this species.





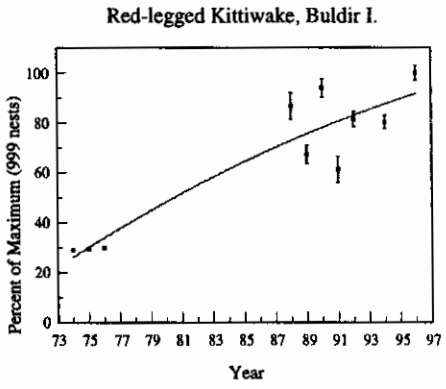


Figure 10. Trends in populations of red-legged kittiwakes at sites monitored in 1996. Error bars are 90% confidence intervals.

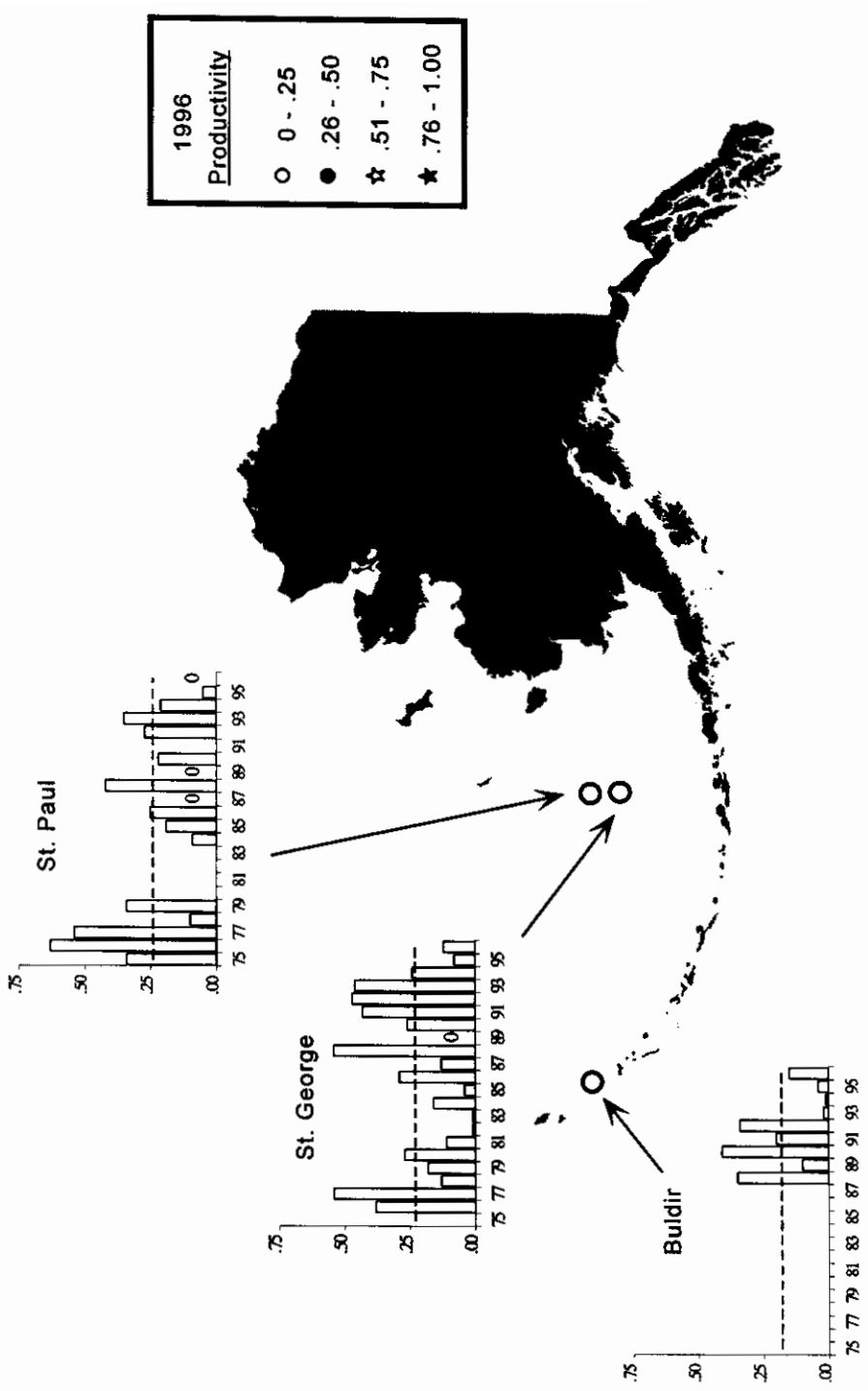


Figure 11. Productivity of red-legged kittiwakes (chicks fledged/nest) at Alaskan sites monitored in 1996. Lack of bars on graphs indicates that no data were gathered in those years. Dashed line is the mean productivity at the site in all years for which there are data.

Common Murre (*Uria aalge*)

Productivity.--At most sites in Alaska, annual productivity normally averages between 55%-70% (Byrd et al. 1993). Reproductive success of common murres was particularly high (>75%) in 1996 at colonies in the central Gulf of Alaska (i.e., Chisik/Duck, Gull, E. Amatuli) (Table 7, Fig. 12). Rates of success were about average (61%-64%) in the Aleutians (Aiktak and Kasatochi) and in the Chukchi Sea (Cape Lisburne). In contrast, common murres had relatively low success (i.e., <50%) at all sites in the eastern Bering Sea (i.e., St. Paul, St. George, Cape Newenham, Cape Peirce) and in southeastern Alaska (i.e., St. Lazaria).

Table 7. Reproductive performance of common murres at Alaskan sites monitored in 1996.

Site	Chicks Fledged/ Nest Site[a]	No. of Plots	No. of Eggs	Reference
Cape Lisburne	0.64 (0.20)[b]	2	33	Roseneau et al. 1997*a*
Saint Paul I.	0.48 (0.07)	5	111	Climo 1997
Saint George I.	0.49 (0.06)	4	61	Dragoo 1997
Cape Newenham	0.38 (0.33)	4	76	Haggblom 1996
Cape Peirce	0.32 (0.09)	10	144	Haggblom 1996
Kasatochi I.	0.61 (0.10)	1	23	Scharf et al. 1996
Aiktak I.	0.62 (0.09)	8	172	Woodward 1997
East Amatuli I.	0.77 (0.14)	10	266	Roseneau et al. 1997*b*
Gull I.	0.87 (0.05)	7	84	Zador et al. 1996
Chisik I./Duck I.	0.78 (0.04)	7	110	Zador et al. 1996
Saint Lazaria I.	0.43 (0.22)	4	60	Slater et al. 1997

[a]Since murres do not build nests, nest sites were defined as sites where eggs were laid.
[b]Standard deviation in parentheses

Populations.--In 1996, common murres were counted at all of the sites where productivity information was gathered (Table 7). Trends could be estimated at most sites (Fig. 13). At Cape Lisburne in the Chukchi Sea, murres have increased since the mid-1970s, particularly since the mid-1980s. In the Bering Sea, increases have occurred since the mid-1980s at St. George, but declines were recorded between the mid-1970s and the mid-1980s followed by no subsequent trends at both St. Paul and Cape Peirce. A similar pattern has occurred in the eastern Aleutians at Aiktak where a decline was followed by a leveling or possibly a slight increase. Finally, in the Gulf of Alaska, it appears common murres have remained stable on East Amatuli Island as a whole since 1989, but an increase is suggested on several study plots.

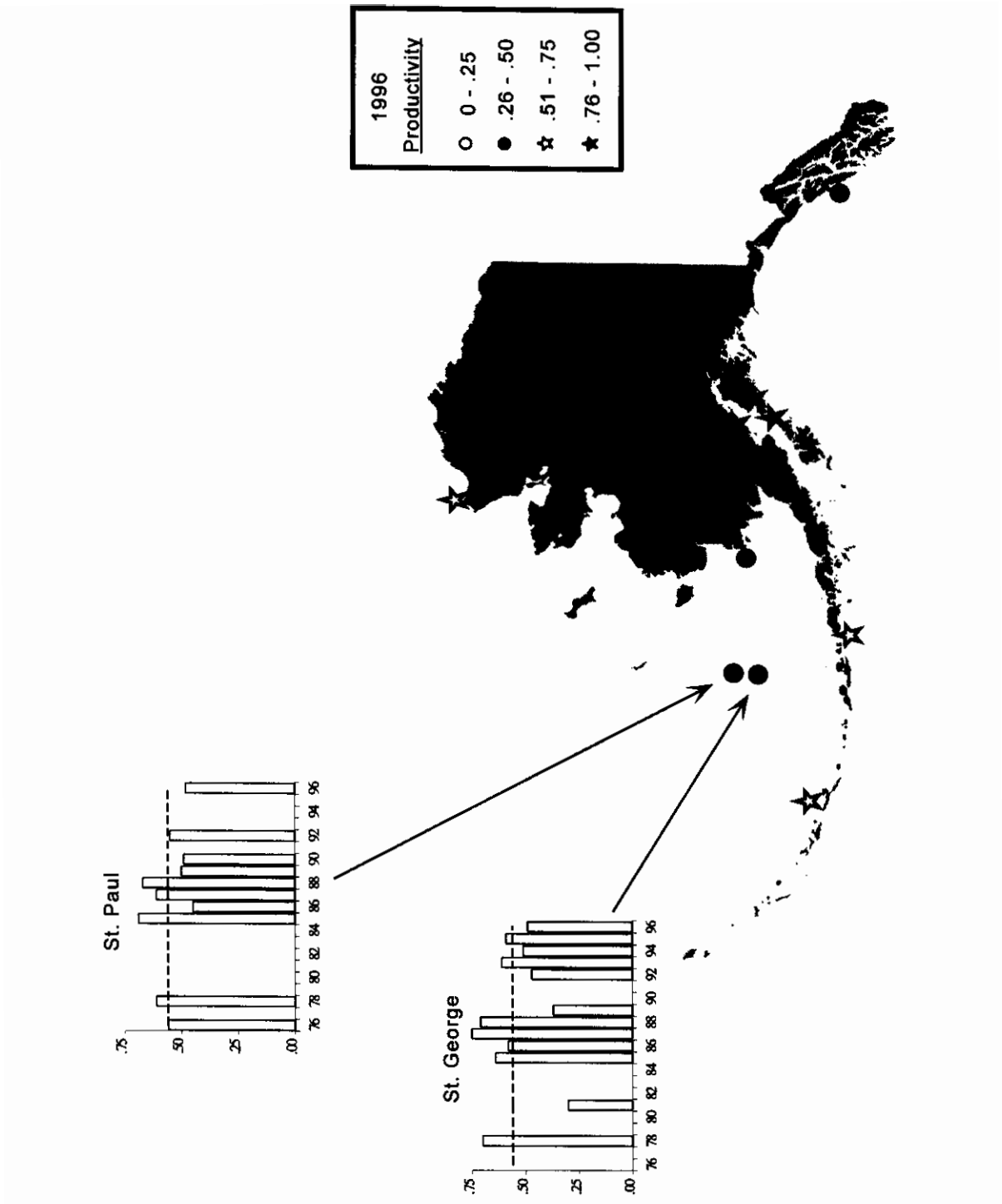


Figure 12. Productivity of common murres (chicks fledged/egg) at Alaskan sites monitored in 1996. Lack of bars on graphs indicates that no data were gathered in those years. Dashed line is the mean productivity at the site in all years for which there are data.

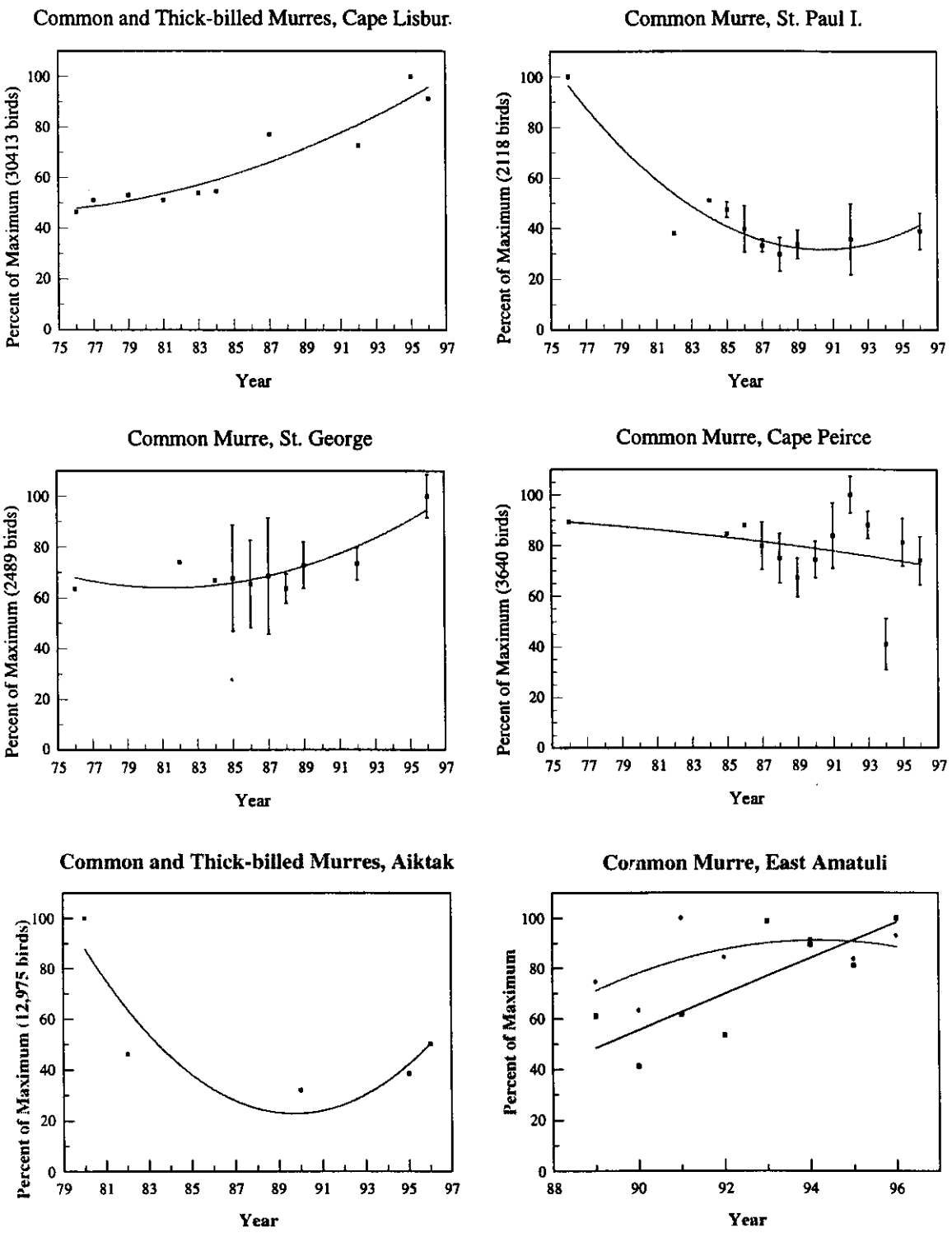


Figure 13. Trends in populations of common murres (or both species where not separated) at sites monitored in 1996. The two lines for East Amatuli reflect trends on a set of plots (lower) and on the entire island (upper). Error bars (90% confidence intervals) are shown for years with multiple counts.

Thick-billed Murre (*Uria lomvia*)

Productivity.--Annual productivity averages for thick-billed murres tend to be slightly lower than for common murres at most sites in Alaska (Byrd et al. 1993). In 1996, reproductive rates were near the site averages in the Pribilofs (St. Paul and St. George) and at Buldir (Table 8, Fig. 14). Although we have little historic data on productivity of murres for the other sites, it appears 1996 was within the "expected" range at Cape Lisburne (0.51), but slightly lower than expected in the central Aleutians (Kasatochi, 0.44). Thick-billed murres had relatively poor success in the eastern Aleutians (Aiktak, 0.30) and in southeastern Alaska (St. Lazaria, 0.29) in 1996.

Table 8. Reproductive performance of thick-billed murres at Alaskan sites monitored in 1996.

Site	Chicks Fledged/ Nest Site[a]	No. of Plots	No. of Eggs	Reference
Cape Lisburne	0.51 (0.17)[a]	12	248	Roseneau et al. 1997*a*
Saint Paul I.	0.50 (0.04)	14	356	Climo 1997
Saint George I.	0.48 (0.05)	11	243	Dragoo 1997
Buldir I.	0.67 (0.04)	12	308	Williams et al. 1997
Kasatochi I.	0.44 (0.07)	8	181	Scharf et al. 1996
Aiktak I.	0.30 (0.06)	1[c]	65	Woodward 1997
Saint Lazaria I.	0.29 (0.16)	3	51	Slater et al. 1997

[a]Since murres do not build nests, nest sites were defined as sites where eggs were laid.
[b]Standard deviation in parentheses
[c]Too few thick-billed murres to have plots. All nests on 8 plots lumped for calculations.

Populations.--Counts were made in 1996 at all sites where productivity information was gathered (Table 8). In addition, murres were counted in 1996 at Tanginak Island, eastern Aleutians (Byrd and Williams 1996). Thick-billed murres were included with common murres in totals for Cape Lisburne (Fig. 13) where increases have occurred since the mid-1970s. Unlike common murres, which increased at St. George, thick-billed murres declined there between 1976 and the mid 1980s (Fig. 15). A similar pattern for thick billed murres was found at St. Paul. Counts in 1996 were similar or slightly higher than counts since the mid-1980s at both St. George and St. Paul. The only other site for which trends could be determined was Buldir in the western Aleutians where thick-billed murre populations have increased substantially since the mid-1970s.

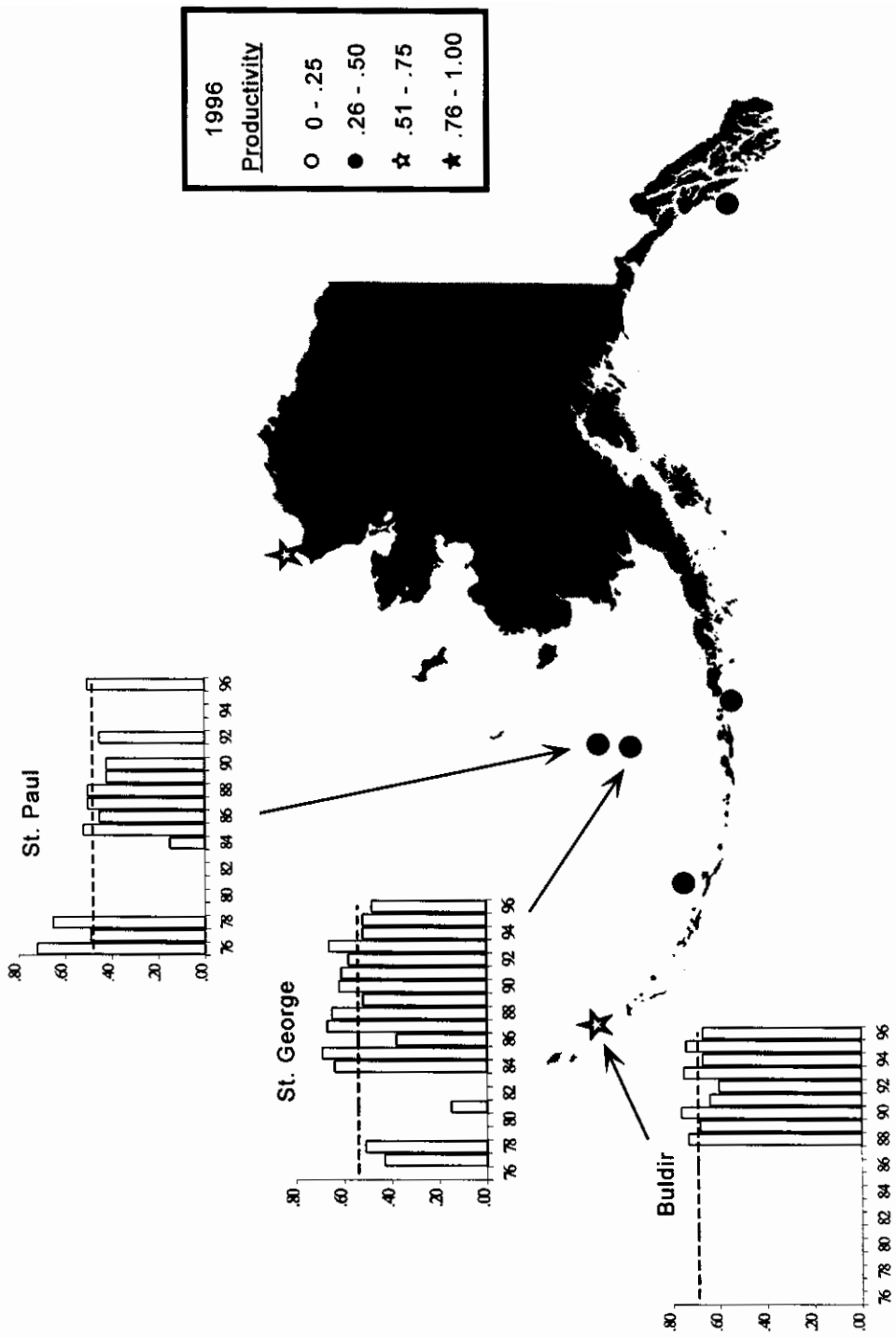


Figure 14. Productivity of thick-billed murres (chicks fledged/egg) at Alaskan sites monitored in 1996. Lack of bars on graphs indicates that no data were gathered in those years. Dashed line is the mean productivity at the site in all years for which there are data.

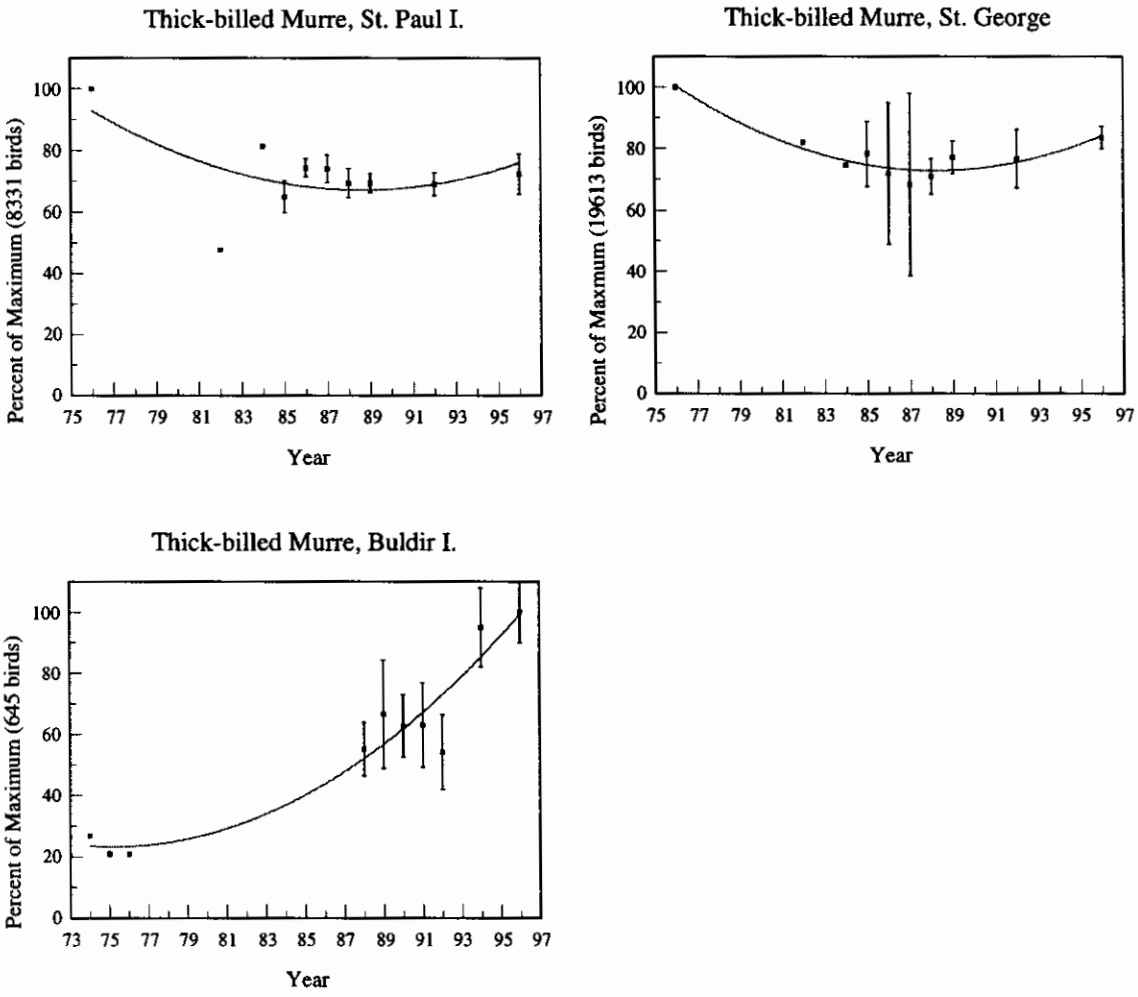


Figure 15. Trends in populations of thick-billed murres at sites monitored in 1996 (thick-billed murres are included with common murres at two additional sites--see Fig. 13). Error bars (90% confidence intervals) are shown for years with multiple counts.

Parakeet Auklet (*Cyclorrhynchus psittacula*)

Productivity.--The only site where we are currently able to monitor this species is Buldir in the western Aleutians. In 1996, productivity was 0.64 chicks nest^{-1} (Table 9). We have little historic data, but parakeet auklets were more successful at Buldir in 1996 than they were in 1991 (0.48 chicks nest^{-1}) (Hipfner and Byrd 1993).

Table 9. Reproductive performance of auklets at Alaskan sites monitored in 1996.

Site/Species	Chicks Fledged/Egg	No. of Nests	Reference
Parakeet			
Buldir I.	0.64 (0.06)[a]	64	Williams et al. 1997
Least			
Buldir I.	0.60 (0.07)	57	Williams et al. 1997
Kasatochi I	0.69 (0.06)	54	Scharf et al. 1996
Whiskered			
Buldir I.	0.70 (0.06)	57	Williams et al. 1997
Crested			
Buldir I.	0.61 (0.06)	66	Williams et al. 1997
Kasatochi I.	0.74 (0.07)	43	Scharf et al. 1996

[a]Standard deviation in parentheses

Populations.--We currently know of no method of monitoring populations of parakeet auklets. Research is needed to develop a method that could be employed at annual monitoring sites in the Aleutians, Pribilofs, and Semidi islands.

Least Auklet (*Aethia pusilla*) and Crested Auklet (*Aethia cristatella*)

Productivity.--Least and crested auklets are being monitored at two sites in the Aleutians (Buldir and Kasatochi). In 1996, reproductive success for both species was approximately 0.6 chicks nest^{-1} at Buldir, but was slightly higher (nearly 0.7 chick nest^{-1}) at Kasatochi (Table 9, Figs. 16 and 17). Jones (1993 *a* and *b*) indicated that least and crested productivity probably averaged 0.50-0.55 chicks nest^{-1}, therefore, 1996 apparently was above average.

Figure 16. Productivity of least auklets (chicks fledged/egg) at Alaskan sites monitored in 1996.

Figure 17. Productivity of crested auklets (chicks fledged/egg) at Alaskan sites monitored in 1996.

Populations.--Plots for monitoring population trends previously have been established at St. Paul (least only), St. George (least only), Buldir, and Kasatochi. In 1996, counts were made only at Kasatochi where there was no evidence of population change for least or crested auklets since the last survey in 1991 (Scharf et al. 1996). An additional set of auklet population plots was set up, and counts were made, in 1996 at Gareloi Island, where introduced foxes were being removed (Paragi 1996).

Whiskered Auklet (*Aethia pygmaea*)

Productivity.--We are able to monitor whiskered auklets only at one site, Buldir (Table 9). In 1996, 0.70 chicks fledged per egg, nearly identical to a 5-year average, up to 1991, for productivity of whiskered auklets at Buldir (Byrd and Williams 1993).

Populations.--Although experiments are being conducted with capture-recapture methods (J. Williams and I. Jones, pers. comm.), no accepted approach for monitoring population trends has yet been developed. Once methods are developed, it might be possible to monitor whiskered auklets at Buldir, Kasatochi/Koniuji/Ulak, and at several less-frequently visited sites.

Tufted Puffin (*Fratercula cirrhata*)

Productivity.--We monitored tufted puffins at four sites in 1996. Byrd et al. (1993) indicated that the average productivity for tufted puffins was 0.46 fledglings per egg, so 1996 was normal at Buldir and Aiktak in the Aleutians, below average at E. Amatuli in the N. Gulf of Alaska, and above average at St. Lazaria in Southeast (Table 10, Fig. 18).

Table 10. Reproductive performance of tufted puffins at Alaskan sites monitored in 1996.

Site	Chicks/ Egg	Chicks/ Occupied Burrow	No. of Plots	No. of Eggs	No. of Burrows	Reference
Buldir I.	0.55 (0.07)[a]		1	51		Williams et al. 1997
Aiktak I.	0.52 (0.11)		3	69		Woodward 1997
East Amatuli I.	0.17	0.31 (0.16)	5	24	61	Roseneau et al. 1997*b*
Saint Lazaria I.	0.80	0.13 (0.14)	7	20	80	Slater 1997

[a]Standard deviation in parentheses

Populations.--Plots for monitoring changes in numbers of nesting tufted puffins have been set up at Buldir, Kasatochi/Koniuji/Ulak, Aiktak, Chowiet, E. Amatuli, and St. Lazaria. Plots were surveyed at all sites except Buldir and Chowiet in 1996. None of the time-series span more than a few years except Aiktak where a slight increase appears to have occurred since 1989 (Woodward 1997) and E. Amatuli where numbers have remained stable since 1993 (Roseneau et al. 1997*b*). In addition to surveying previously established plots at annual monitoring sites, new plots were set up in 1996 at less-frequently visited sites in the eastern Aleutians (Kaligagan Is., Egg I., and the Baby Is., Byrd and Williams 1996).

Figure 18. Productivity of tufted puffins (chicks/egg) at Alaskan sites monitored in 1996.

Horned Puffin (*Fratercula corniculata*)

Productivity.--Horned puffins were monitored at Buldir (0.59 fledglings egg^{-1}) and Chisik/Duck (0.66 fledglings $egg^{-1)}$ in 1996 (Table 11, Fig. 19). The average for 18 estimates of productivity reported by Byrd et al. (1993) was 0.57 fledglings egg^{-1}, therefore, success rates in 1996 were slightly above average.

Table 11. Reproductive performance of horned puffins at Alaskan sites monitored in 1996.

Site	Chicks/Egg	Hatching Success	No. of Plots	No. of Eggs	Reference
Buldir I.	0.59 (0.07)[a]	0.73 (0.06)		49	Williams et al. 1997
Chisik I./Duck I.	0.66 (0.07)	0.86 (0.07)	4	55	Zador et al. 1996

[a]Standard deviation in parentheses

Populations.--Although plots have been set up at Buldir to monitor trends in horned puffins, no accepted method of monitoring has been developed, and no counts were made in 1996.

Figure 19. Productivity of horned puffins (hatching success) at Alaskan sites monitored in 1996.

CONCLUSIONS

Species Differences

Surface Plankton-Feeders.--Apparently 1996 was a good year for storm-petrels, the species we use to sample this part of the marine food web. Both fork-tailed (FTSP on Table 12) and Leach's (LESP) storm-petrels had above average reproductive success at monitoring sites in southeast Alaska and in the Aleutian Islands (Table 12).

Surface Fish-Feeders.--Glaucous-winged gulls are treated here, although they are opportunistic feeders taking other birds as well as fish for prey. We had one sampling site in each of the regions except the n. Bering and Chukchi. Gulls had average success in 1996 at the sites in the SE Bering Sea and in the N Gulf of Alaska, but they had lower than average success in the SW Bering and in Southeast Alaska (Table 12).

Black-legged kittiwakes (BLKI) had average or above average success in the Gulf of Alaska except for a single site (Chisik) high up in Cook Inlet where the species has not done well in recent years. In contrast, poor success was recorded in the southeastern Bering Sea and at C. Lisburne in the Chukchi Sea. Interestingly, kittiwakes were able to produce normally at Bluff in Norton Sound, although it is located between the C. Lisburne and SE Bering Sea sites. In the SW Bering Sea productivity was normal, although normal is relatively low at Buldir. Red-legged kittiwakes were below normal in the Pribilofs, but normal at Buldir (Table 12).

Diving Fish-Feeders (nearshore).--At least one species of cormorant was monitored in every region. Like other nearshore feeders, reproductive success may be based on very local conditions which may not prevail region-wide. There was no overall pattern for reproductive success of cormorants even within regions. Pelagic cormorants (PECO) had below average success at 4 sites, average success at 2 sites, and above average success at 2 sites. Red-faced cormorants (RFCO) had above average, average, and below average success at one site each (Table 12).

Diving Fish-Feeders (offshore).--Murres had average reproductive success in 13 of 17 cases (Table 12). Common murres (COMU) were below average at only one site, Cape Peirce, and above average at one site, Gull I., whereas thick-billed murres (TBMU) were below average at St. Lazaria, but average everywhere else we monitored them.

Tufted puffin (TUPU) reproductive success was average in the southern Bering Sea in 1996, but the species had poor success at E. Amatuli in the N Gulf of Alaska (Table 12). Horned puffins (HOPU) appeared to have average success at Chisik in the N. Gulf of Alaska, but the species had below average success at Buldir in the SW Bering Sea in 1996.

Diving Plankton-Feeders.--Least (LEAU) and crested (CRAU) auklets had average success in the SW Bering Sea in 1996, the only region where these species were monitored (Table 12).

Table 12. Seabird relative productivity levels compared to averages for past years at within regions.

Region	Site	Storm-petrel FTSP/LESP	Cormorant PECO/RFCO	Gl.-wing Gull	Kittiwake BLKI/RLKI	Murre COMU/TBMU	Auklet LEAU/CRAU	Puffin TUPU/HOPU
Southeast								
	St. Lazaria	+/+	+/*	--		=/--		+ /*
N. Gulf of Alaska								
	PWS				=/*			
	Chiniak		--/*		=/*			
	Barrens				+/*	=/*		--/*
	Gull		=/+	=	+/*	+/*		
	Chisik				--/*	=/*		*/=
SE Bering								
	C. Peirce		--/*		--/*	--/*		
	St. Paul		*/=		--/--	=/=		
	St. George				--/--	=/=		
	Aiktak	+/+	--/*	=		=/--		=/*
N. Bering/Chukchi								
	Bluff		--/*		=/*			
	C. Lisburne				--/*	=/=		
SW Bering								
	Kasatochi	+/*	+/--		=/*	=/=	=/=	
	Buldir	+/+	=/*	--	=/=	*/=	=/=	=/--

Abundance Codes	
	"--" indicates productivity was >20% below average for the site or region,
	"=" indicates within 20% of average,
	"+" indicates >20% above average,
	"*" indicates the species (in particular species pairs) was not present or was not monitored in 1996.

Regional Differences

N. Bering/Chukchi.--At Bluff in the N Bering, cormorants had poor success in 1996, but black-legged kittiwakes reproduced normally. In contrast, kittiwakes failed at Cape Lisburne in 1996, but murres reproduced normally there (Table 12).

SE Bering.--Storm-petrels apparently had adequate plankton at the surface to fuel above average reproduction in 1996 in this and other regions, but in the SE Bering nearshore fish-feeders (PECO) and surface fish-feeders (BLKI and RLKI) had below average success. Although diving fish-feeders (COMU and TBMU) generally produced at average levels, two cases were noted in this region where they were below average in 1996.

SW Bering.--Species using all parts of the food web had average or above success in this region in 1996 (Table 12).

N. Gulf of Alaska.--With a few exceptions (e.g., kittiwakes at Chisik), this region had the best overall success in 1996. Only fish-feeding species were monitored, but both surface and diving species generally had average or above success (Table 12).

Southeast.--Except for thick-billed murres, a species near the edge of its range in southeastern Alaska, species using both plankton and fish portions of the food web had average or better success in 1996.

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