# Auklet Demography and the Influence of Norway rats at Kiska Island – report on results of monitoring to 2009

Least Auklet adult at Sirius Point, Kiska Island by ALB – June 2009

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## *Executive Summary*

We quantified productivity and survival of Least and Crested Auklets, and measured the abundance and distribution of Norway Rats, at Sirius Point, Kiska Island, Alaska from May-August 2009. Overall, Least Auklet productivity (0.44) was the lowest recorded at Kiska since 2002, and significantly lower than on nearby, rat-free Buldir Island (0.74). Crested Auklet productivity (0.52) was also lower than Buldir (0.87) in 2009. Survival of Least Auklets from 2007-2008 (the most recent estimate) was 0.66, the lowest estimate from 2001-2008. Rat abundance, based on our indexing method, was essentially the same as 2008, though rats appeared to have some effect on auklet breeding success this year. Continued monitoring of auklet demography at Kiska is necessary to further quantify natural variability at this large auklet colony and to further understand the effects of rats on Crested Auklets' breeding biology and demography. Under present conditions and in the absence of immigration from other colonies, the Least Auklet population at Sirius Point is expected to decline rapidly over the next two decades.

## *Introduction*

The large auklet (*Aethia* spp.) colony at Sirius Point, Kiska Island, Aleutian Islands, Alaska (52°08'N, 177°37'E), has over a million Least (*Aethia pusilla*) and Crested Auklets (*A. cristatella*) and covers more than 1.8 $km^2$ in area (Jones *et al.* 2001; Byrd *et al.* 2005). Due to the enormous numbers present, and spatial extent of the colony, estimating, or even observing, population-level effects of introduced predators is a difficult proposition. Norway rats (*Rattus norvegicus*) were introduced to Kiska during the military occupations of 1942-1946 (Murie 1959), and likely present a long-term threat to breeding seabirds on the island, including auklets (Major *et al.* 2006; Major *et al.* submitted). This was our ninth year of monitoring auklet demography, and rat abundance and distribution at Kiska. Our cumulative observations have shown that when rat abundance is high, auklet productivity is low (e.g., the years 2001-2002), but rat abundance has been, for some unknown reason, highly variable and unpredictable among years. A quantitative method of indexing rat abundance was devised (Eggleston et al. in prep) and implemented at Sirius Point in 2006 (Eggleston and Jones 2006), refining our ability to correlate rat activity with auklet population parameters. Nevertheless, only long-term demographic monitoring and modelling will indicate whether auklets and rats are in stable coexistence at Kiska.

Sirius Point is a critical breeding site for auklets because it contains the largest patch of available auklet breeding habitat in the Aleutians in the form of a 45-year-old lava dome (Coats *et al.* 1961; Simkin *et al.* 1981). It is also home to about 5% of the global Least Auklet and Crested Auklet populations (Gaston and Jones 1998) and is the largest Least Auklet colony in the Aleutian Islands (Byrd et al. 2005). Understanding the population dynamics of auklets in relation to rats is therefore critical to their successful management and conservation in Alaska.

In summary, the objectives of our overall study were to:

1) Quantify Least and Crested Auklet productivity from representative areas of the Sirius Point colony for the 2009 breeding season,

2) Identify causes of auklet breeding failure (especially if involving rats),

3) Quantify Least Auklet annual adult survival at one representative study plot for 2001-2008 from resightings of previously colour-marked birds in 2009 (again assessing possible effects of rats),

4) Redeploy a rat monitoring transect protocol to quantify inter-year variation in relative abundance of rats at Sirius Point, and

5) Identify the remaining key questions about rat impacts on seabirds at Kiska Island.

In addition, we are also conducting detailed analysis of diet, moult and general biology of auklets as well as diet of rats, although these analyses are ongoing and will be presented elsewhere.

## ***Methods***

*Auklet Productivity*

Least and Crested Auklet productivity was measured at Sirius Point, Kiska Island using established methods (Fraser *et al.* 1999; Major *et al.* 2006) that have been employed consistently since 2001. In short, we visited breeding sites every 4-7 days, and determined their status (empty, egg, chick, adult, unknown). We considered sites active when we found an adult on two consecutive visits, or we saw an egg. We scored sites as successful in fledging a chick if the chick disappeared after 25 days (Least Auklets, Roby and Brink 1986) or 26 days (Crested Auklets, Fraser *et al.* 1999). We defined reproductive success as the proportion of active nests from which chicks fledged. We used apparent estimates of reproductive parameters (chicks fledged per pair) rather than a Mayfield-corrected estimate since we were interested in the relative measures of reproductive performance, not absolute estimates (Johnson 2007). We also assumed that any biases created by using apparent estimators were consistent across all years. Furthermore, Major *et* *al.* (2006) found that Mayfield estimates for Least Auklet productivity at Kiska Island from 2001-2003 did not differ from uncorrected estimates as presented here. We began searching for active nests within 3-4 days in any given year, and so effects of left truncation, or the inability to detect nests that failed prior to the first visit (Johnson 2007), would be uniform across the study. Similarly, a single criterion was used to infer successful fledging, meaning that differences in reproductive success reported here were not due to methodological differences.

Any failed crevice was examined closely to determine the cause of failure, including whether rat predation was responsible. These data were compared to similar data collected at the auklet colony at Main Talus, Buldir Island (52°23'N 175°55'E) using the same protocol. Buldir has no rats, its colony is only about 100 km from the colony at Sirius Point, and thus provides a useful comparison to Sirius Point in determining the effect of rats on auklet productivity. Previously (2001-2007), our auklet productivity data were compared to those from Kasatochi Island, but the volcanic eruption at Kasatochi in August 2008 ended auklet monitoring there. At Kiska, we used three plots to estimate productivity at Sirius Point (New Lava, Old Lava Low and Old Lava High), and these are believed to be representative of the auklet colony at present (Jones et al. 2001, Major et al. 2006). We used a generalized linear model in SPSS 16 (SPSS Inc., Chicago, IL, USA) to examine differences among plots and between islands. Values were considered significant when $p < 0.05$.

*Timing of Breeding*

We estimated date of hatching for a sample of Least Auklet nests. We included only nests that we scored as an egg on one visit, and as a chick on the very next (4-7 days later), and we assumed hatching date to have occurred at the midpoint between the two visits. Again, these data were compared to both long-term data from Kiska and Buldir islands. Analysis of variance (ANOVA) was used to test for differences among plots on Kiska, and between Buldir and Kiska islands.

*Auklet Survival*

A population of marked Least and Crested Auklets of unknown age was established on a single plot on the 1964 lava dome in 2001 (Jones et al. 2001) A capture-mark-resighting protocol to measure annual survival on this study plot has been employed each year (2001-2009). Birds were captured on the 50 $m^2$ plot using noose carpets and adults and were marked with a uniquely-numbered metal band and combination of Darvik colour bands (Jones *et al.* 2002; Jones *et al.* 2004). We did not colour-band subadults (two-year-old individuals, identified using criteria in Bédard and Sealy (1984) as having worn, brown flight feathers and foreheads), and they were not included in the analysis. We resighted colour-marked auklets during their main activity periods (0900-1500 and 2200-0030 Hawaii-Aleutian Standard Time) from late May to early August each year, encompassing the entire breeding cycle. Using procedures described in Lebreton et al. (1992), annual probabilities of survival ($\phi$) and resighting ($p$) were generated using Program MARK (White and Burnham 1999). Because our capture technique captures both breeding and non-breeding individuals, some individuals are never seen again after marking (Jones *et al.* 2002; Jones *et al.* 2007). These transient "prospectors" result in a lower estimate of survival on the first occasion after marking (Pradel *et al.* 1997; Prévot-Julliard *et al.* 1998; Bertram *et al.* 2000; Jones *et al.* 2007). To account for this permanent emigration, we included a transient term that modelled survival estimates for the period following capture independently of estimates in subsequent years. This results in the first estimate of survival being the product of both survival and permanent emigration from the study plot (Pradel *et al.* 1997).

We tested the goodness-of-fit of the global model to the data using 100 parametric bootstraps (Jones *et al.* 2002; Jones *et al.* 2007). From these bootstraps, we obtained the mean model deviance and mean $\hat{c}$, a measure of overdispersion, or extra-binomial variation. This variation arises when assumptions of the model are not met, such as variation in the recapture rates of individuals (White and Burnham 1999; Burnham and Anderson 2002). The observed deviance and $\hat{c}$ were divided by the mean values from the bootstraps and the higher of the two values was taken as an estimate of overall overdispersion, $\hat{c}$. We restricted our candidate models to the global model, plus a series of reduced parameter models. We did not construct every reduced parameter model, many of which would have poor fit, but rather we used the approach of Lebreton et al. (1992) by first modelling recapture rates to determine the best structure for recapture rates and then modelling survival rates.

Model selection was based on quasi-Akaike Information Criteria adjusted for small sample size and overdispersion ($QAIC_c$). Models with lower $QAIC_c$ values were considered the best compromise between a good fit to the data and overparameterization of the models (Burnham and Anderson 2002). We also calculated Akaike weights, which indicate how well a model fits the data when compared with other models (Burnham and Anderson 2002). Throughout, we used model notation from Lebreton et al. (1992) where we described the parameterization explicitly ($y_1$ = first year after capture, t = variation with time). We used year classes rather than age classes as the marked individuals were of unknown age.

*Norway Rat Abundance and Distribution*

Because a census method for rats using snap-traps is not feasible at Sirius Point because of the large auklet population, detection using chew marks at stations set across the auklet colony was recommended and an indexing protocol (Eggleston and Jones 2006). Following this protocol, wax blocks were set at the same stations and along the same transect lines used from 2006-2008 (Eggleston and Jones 2006; Bond and Jones 2007, 2008). Eighty stations (8 transects of 10 stations with stations approximately 25m apart) covered representative habitat types of the Sirius Point auklet colony. Two replicate six-day monitoring trials were carried out, with one during 11-16 June and another during 11-16 July. Differences among plots, between months and among years were tested using a generalized linear model, and model selection was done using $QAIC_c$ as described for survival estimates. Multiple comparisons were made using 95% confidence intervals of estimated marginal means from the best-fitting generalized linear model, and differences were considered significant when confidence intervals did not overlap.

*Vegetation Changes*

In order to quantify vegetation cover on the Sirius Point colony site for comparison with past and future surveys, we measured vegetation cover at representative plots. During the last two weeks of July, we performed vegetation surveys using $4m^2$ quadrats placed at each rat transect station (coordinates given in Eggleston and Jones 2006). At each station, two individuals estimated the percent cover of the dominant vegetation types identified in previous surveys (Deines and McClellan 1987; Jones *et al.* 2001). Estimates from each observer were averaged on each $4m^2$ plot to reduce the variability and error associated with estimates of percent cover. We did not examine vegetation in the Gullies or on one transect of Old Lava Low.

*Additional Observations*

A list of bird species identified from 27 May – 08 August is presented in Appendix I, and a summary of Norway rat sign observations is in Appendix II. Throughout the season, attempts were made to document all bird species that may be breeding at Sirius Point, either by finding a nest or fledged young.

## Results

*Least Auklet Productivity & Phenology*

There was no difference among plots in hatching success ($\chi^2$ = 0.81, p = 0.67) or overall reproductive success ($\chi^2$ = 1.90, p = 0.39), so data from all plots were pooled. Hatching success was 0.82, essentially unchanged over recent years, and not significantly different from Buldir in 2009 ($\chi^2$ = 0.93, p = 0.34). Reproductive success was the lowest observed since 2002 with only 0.44 chicks fledged per pair. Overall reproductive success was significantly lower on Kiska than on Buldir in 2009 ($\chi^2 = 19.55$, $p < 0.001$). See Table 1 for complete productivity details.

There was no significant difference among plots in Least Auklet breeding phenology as assessed by hatching date ($F_{2, 55} = 0.29$, $p = 0.75$), so data were pooled. Overall, the mean hatching date was 01 July ± 4.34 days (n = 58 nests). From 2002-2008, the mean annual hatching date ranged from 28 June to 05 July. Least Auklet phenology was significantly later on Kiska than Buldir in 2009 (mean hatching date on Buldir: 25 June; $F_{1, 98} = 51.81$, $p < 0.0001$).

*Crested Auklet Productivity & Phenology*

Our small sample size did not allow us to test differences among plots in Crested Auklet hatching or reproductive success. Hatching success (0.91) was the highest observed since 2006, the second highest since monitoring began in 2001, and not significantly different from Buldir in 2009 ($\chi^2 = 0.19$, $p = 0.66$). Overall reproductive success was the lowest since 2003, however, with 0.52 chicks fledged per pair. This was significantly lower than Buldir in 2009 ($\chi^2 = 4.47$, $p = 0.03$). See Table 3 for complete productivity details.

There was no significant difference in breeding phenology among plots (ANOVA, $F_{2, 6} = 0.74$, $p = 0.52$), so data were pooled. The mean hatching date was 27 June ± 4.87 days (n = 9), however we do not have sufficient data to make comparisons with other years at Kiska. Crested Auklets did hatch significantly earlier than Least Auklets on Kiska in 2009 ($F_{1, 65} = 7.21$, $p = 0.009$), but significantly later than Crested Auklets on Buldir ($F_{1, 56} = 5.61$, $p = 0.021$).

*Least Auklet Survival*

The top-ranked model included survival varying with year and three groups of recapture rates (Table 6). Survival from 2007-2008 (the latest that can be estimated) was 0.658, the lowest since our study began in 2001. This follows a high survival rate of 0.913 in 2006-2007. Full details, including annual estimates of survival and estimates of recapture rate are presented in Table 7.

*Crested Auklet Survival*

For the first time, we estimated Crested Auklet apparent annual survival at Sirius Point. We urge caution in drawing conclusions from this analysis, as our sample of marked birds was small (Table 5b). The top-ranked model included a transient effect, where survival for the period immediately following banding was lower than other occasions (Table 8). Crested Auklet survival has been declining steadily, and in 2007-2008 was 0.731. Full details are provided in Table 9.

*Norway Rat Abundance and Distribution*

The top-ranked model included effects of month and location. There were more hits on was block stations in July than in June, and based on overlapping 95% confidence estimates of marginal means, the Gullies and Old Lava Low received more hits than other transects in 2009 (Table 10).

The best-fitting model included only the main effects of year, month, and plot. Among years, there were significantly more rat detections in 2006 other years ($p < 0.001$), and significantly fewer rat detections in 2007 ($p < 0.001$); detections in 2008 and 2009 were not different statistically ($p = 0.40$). Rats were detected more often in the Gullies than other plots ($p < 0.001$), and there was no difference in detections between New Lava and Old Lava Low (0.27); no rats have been detected using wax blocks on Old Lava High. Following the July 2009 series of transects, we left wax blocks in place on Old Lava High until 29 July, and detected rats at the two lowest stations. Finally, there were significantly more rat detections in July than in June ($p = 0.001$).

There was no significant relationship between rat abundance and hatching, fledging or overall reproductive success in either Least (all $p > 0.08$) or Crested Auklets (all $p > 0.14$) from 2006-2009. Apart from Least Auklet hatching success ($p = 0.08$), all other relationships were highly insignificant (all $p > 0.14$). Using only data from the Gullies in July (the place and time rats were most likely to be detected), there were, again, no significant relationships between auklet demographic parameters and rat abundance (all $p > 0.14$).

*Vegetation Changes*

A summary of vegetation percent cover is presented in Tables 11 and 12. Overall, New Lava was dominated by *Puccinellia* spp. (57%) and moss/lichens (16%). Old Lava Low consisted mainly of *Carex* spp (35%), ferns (25%), and *Calamagrostis* spp. (23%). On Old Lava High, ferns comprised 30% of cover and *Carex* spp. 25%. Long-term comparisons on Old Lava High are tentative because of different sampling times in 1986, 2001 and 2009, although we recorded a significant increase in ferns (2% in 1986, 9% in 2001, 30% in 2009) and *Carex* spp. (2% in 1986, 3% in 2001, 25% in 2009). The percent cover of *Calamagrostis* spp. decreased from 66% in 2001 to only 16% in 2009. All other vegetation types were very similar to those recorded in 2001.

## Discussion

*Least Auklet Productivity & Phenology*

There was a sharp statistically, and likely biologically, significant decline in productivity between 2008 and 2009 by 0.20 chicks/nest, despite the relatively similar numbers of Norway rats. This was the lowest level of reproductive success observed since the complete failures in 2001 and 2002. Some of the decline may be attributed to a major rain and wind event in early July (shortly after the peak date of hatching), following which many chicks were found dead in their crevices. Large numbers of small dead chicks were found in 2001 and 2002, and this was attributed to inattentive parents caused by rat disturbance (Major et al. 2006). It is possible that rats did affect reproductive success negatively in this indirect way again in 2009. A similar rain event occurred on Buldir at the same time, yet reproductive success on Kiska was still lower than on Buldir in 2009, further implicating some factor intrinsic to Kiska in decreasing Least Auklet breeding success.

At Buldir nearly all of the auklet crevices monitored annually are the same ones checked from one year to the next (ILJ). In contrast, at Kiska, an additional 10-30 new crevices need to be located and marked each year to maintain an adequate sample of nests for productivity analysis. At present, there are 398 marked crevices, of which only 164 were occupied (i.e., a high proportion of suitable breeding sites are unoccupied). As Least Auklets have typically high nest-site fidelity (Roby and Brink 1986; Jones and Montgomerie 1991), this suggests that some combination of factors may be at play. These could include: 1) that disturbance caused by rats or investigators has differentially reduced fidelity at Sirius Point; 2) that there are more high quality breeding sites at Kiska than pairs of auklets; or 3) that the auklet population is declining (Major et al. submitted), resulting in more unoccupied nest sites.

Finally, Least and Crested Auklet phenology on Kiska was significantly later than on Buldir in 2009. This might be expected as the great number of birds present at Kiska may generate greater competition for food and delay reproduction. However, there is evidence for other auks that pairs breeding later in the season are of poorer quality (Lloyd 1979; Harris 1980; De Forest and Gaston 1996). It has also been hypothesized that caching behaviour by rats when auklets first arrive at the colony in May could eliminate older, more experienced breeding auklets that tend to breed earlier (Major et al. 2006). Consequently, it may be that some interaction involving rats, monitoring of less experienced birds, and breeding site use/abandonment could explain differences between Buldir and Kiska.

*Crested Auklet Productivity*

Crested Auklet productivity appears to have been relatively unaffected by rats and has remained consistently between 0.4-0.6 chicks fledged/pair, except for higher success in 2004 and 2006. Locating Crested Auklet crevices to monitor on Kiska is more challenging because the Sirius Point colony contains 80% Least Auklets and only 20% Crested Auklets (Day *et al.* 1979; Byrd *et al.* 2005; Jones and Hart 2006), so Crested Auklet nest crevices were inherently less likely to be sampled. Secondly, Crested Auklets tend to nest much deeper in talus slopes and lava formations than Least Auklets (Bédard 1969), making active nests much harder to find and monitor. Finally, the initial sample of crevices monitored (on three plots, Jones *et al.* 2001; Major *et al.* 2006) was in areas of the colony with low densities of Crested Auklets. These points may suggest that greater efforts to monitor Crested Auklets should be made at Kiska in future years.

Nevertheless, we believe the survival of Least Auklet eggs and chicks in crevices at Sirius Point is likely to be an appropriate proxy for the survival of Crested Auklet eggs and chicks because nether species defends their nests actively, and chicks of both species are helpless, unaccompanied by an attending adult for the majority of the nestling period (Jones 1993b, a), and thus at least equally vulnerable to attack by rats.

Very few Crested Auklet nests have been monitored on New Lava (total for all 2001-2009 = 42), but in five of these years, no chicks fledged. In total, only six Crested Auklet chicks fledged in monitored crevices on this plot from 2001-2009. This evidence, although limited, leads us to believe that rat predation or disturbance in this area could be a significant cause of Crested Auklet reproductive failure.

As with Least Auklets, Crested Auklets tended to breed later this year on Kiska than on Buldir, although the sample size of nests from Kiska for which we had hatching date was small (n = 9). Future years should focus on Crested Auklet breeding biology at Kiska, and its relationship to rats.

*Least Auklet Survival*

Survival over the period 2007-2008, the most recent estimate possible, was the lowest since monitoring began in 2001 (0.66) and follows an estimate of 0.91 for 2006-2007. The mean estimate of annual survival (approximately 82%) is lower that the 87% found on Buldir from 1990-2000 (Jones et al. 2002). Using survival data from 2001-2007 and reproductive success data from 2001-2008, Major et al. (submitted) predicted that the Least Auklet colony at Sirius Point would decline by 63% (in the absence of immigration) over the next 20 years, assuming that years of high rat abundance similar to 2001 and 2002 occurred twice in every decade. Further, they found that the population trajectory was most influenced by changes in adult survival, followed by reproductive success. The low estimate of survival for 2007-2008 and the low productivity for 2009 foreshadow an even more rapid decline.

*Crested Auklet Survival*

We examined Crested Auklet survival for the first time this year. Although birds have been marked since 2001, only 30 individuals were marked from 2001-2006 (Table 5b). We marked larger numbers of individuals in 2007-2009, and therefore attempted our first analysis this year. The estimate for 2007-2008 was the lowest recorded (0.73), and follows a declining pattern from 2002. This is very similar to the estimate of 0.77 when only birds marked or seen in 2007 are included in the analysis (n = 79 individuals). The mean estimate over the period 2001-2008 was 88%, higher than the 85.9% reported from Buldir over 1991-2001 (Jones et al. 2004), although our estimates included two years of 100% survival and six of the seven estimates are based on data from only 30 individuals, and so should be interpreted with caution. Additional years with larger banding efforts (> 30 individuals marked) are required to fully resolve patterns in survival of Crested Auklets at Sirius Point.

Despite the lowest survival estimate for both Least and Crested Auklets occurring in 2007-2008, survival estimates were not correlated between the two species ($r = 0.20$, $p = 0.67$), suggesting that they may be responding differently to both oceanography and rats.

*Norway Rat Abundance and Distribution*

Rats were present in numbers similar to 2008, that is, lower than 2006 but higher than 2007. Detections were located in both Gullies and on the lower-elevation transects of Old Lava Low. Wax blocks were maintained on the two Old Lava High transects from 11-29 July to ascertain whether rats were present at all in this part of the colony during the auklet breeding season, or whether they did not occur at such elevations until the autumn (Bond and Jones 2008). Two detections were made, one at the lowest-elevation station of each transect. This indicates that rats have the potential to affect auklet reproductive success on all three plots throughout the season, even in years of seemingly low abundance.

In each year, high numbers of detections have been found in Glen Curly, including the only detection in 2007 and the majority of detections in 2008 and 2009. This area borders the 1964 lava dome on the east and an area not occupied by auklets on the west. Why rats are more abundant here than nearby Glen Larry or on the Old Lava Low transects is, at present, unknown. Rats undoubtedly make use of the intertidal zone at Steam Beach and Tangerine Cove during the winter and spring (Witmer *et al.* 2006; Kurle *et al.* 2008), and so the Gullies could represent similar refugia, especially early in the season when snow cover at higher elevations may limit the rats' distribution (ALB, ILJ pers. obs.). Alternatively or in addition, due to its geological funnel-like structure, Glen Curly could be a route for rat dispersal inland from the beach areas through spring and summer.

Rat abundance was not correlated significantly with any reproductive parameter in either Least or Crested Auklets during 2006-2009. This is, however, based on only four years' rat abundance data (2006-2009) from the indexing protocol (Eggleston et al. in prep), and in none of these years were rats as qualitatively abundant as 2001 or 2002. Additional years' data are urgently needed to understand the exact relationship between rat abundance and auklet productivity quantitatively. It may take ten or more years to detect the relationship statistically (less if Kiska experiences plague-levels of rat abundance as experienced in 2001-2002).

*Vegetation Changes*

We believe that differences in the plant communities between 2001 and 2009 are due largely to different sampling times, and we suggest that in the future, vegetation surveys be conducted during the last two weeks of July in order to make results more comparable. Despite this source of uncertainty, the general trend observed by Jones et al. (2001) of advancing plant succession is continuing, with dense grasses and very little moss, lichen, or bare rock present on Old Lava Low and Old Lava High. The abundance of short grasses (*Puccinellia* spp.), moss, lichens and bare rock on New Lava adds further evidence that this will be excellent auklet nesting habitat for at least a few more decades.

*Additional Observations*

There were no Glaucous-winged Gull (*Larus glaucescens*) nests near camp this year. Two fledged chicks were observed with congregations of adults in early August. The number of gulls present at the end of the season was often > 50 individuals of all age classes – a drastic increase since 2001.

Winter Wrens (*Troglodytes troglodytes*) seemed more abundant in 2008 and 2009 than in 2007, although no systematic surveys were conducted. Unfortunately, two were caught and killed in rat snap traps set to defend our food cache near camp.

Song Sparrows (*Melospizia melodia*) did not breed at Sirius Point in 2009, but up to five individuals were seen together in late July / early August, indicating possible post-breeding dispersal from Little Kiska. In addition, single individuals were seen at intervals of 2-3 weeks throughout the summer, whereas no sparrows were encountered in 2008 until the end of July.

For the third year in a row, a large number of fledgling Least Auklets and smaller numbers of Crested Auklets were found dead in Glen Larry in what we believe to be a toxic gas vent. This is the area of the birds presumed killed by wind in 2007 (Bond and Jones 2007). We performed a quantitative analysis of atmospheric gases at this site this year. Preliminary analysis suggests few differences from standard atmospheric composition, and the final results of this investigation will be published in a peer-reviewed journal in the near future.

As compared with 2008, there was very little snow in 2009, and much less rain or fog. Despite this, strong weather events did occur, including one rainstorm in mid-July, which we believe may have caused many chicks to die from hypothermia, as all small dead chicks were found on the productivity check immediately following this gale.

## *Conclusions and Recommendations*

1. Additional years of simultaneous monitoring of auklet population parameters with monitoring rat abundance and distribution using a quantitative method, especially during years of high rat abundance such as 2001 and 2002, are required to measure the effects of rats on auklet demography accurately.
2. The current status of Crested Auklets at Kiska, where they represent over 35% of the Aleutian Islands population, is poorly understood. A larger number of marked individuals for survival analysis, and of breeding crevices to monitor productivity are required to assess the effects of rats on this species' demography.
3. An assessment of immigration among auklet colonies in the Aleutian Islands and Bering Sea would be useful for predicting population changes at Sirius

Point, where the Least Auklet population is predicted to decline significantly over the next two decades in the absence of immigration. This, combined with predicted declines at other colonies in the Aleutians due to vegetative succession, and the loss of Kasatochi as a breeding site in the short term, is cause for concern about the status of auklets in the Aleutian chain. Capture-mark-recapture would not likely present a feasible method of detecting inter-colony movement, leaving only a genetic study as a viable option (expensive).

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## *Tables*

**Table 1.** Least Auklet productivity and known causes of breeding failure as measured from three plots at Sirius Point, Kiska Island, Alaska in 2009.

| | Lava Dome | Old Lava 'Low' | Old Lava 'High' | Kiska Total |
|---|---|---|---|---|
| Crevices monitored, n (a) | 78 | 33 | 53 | 164 |
| Number hatched (b) | 62 | 28 | 45 | 135 |
| Egg abandoned | 1 | 0 | 1 | 2 |
| Egg disappeared | 7 | 3 | 7 | 17 |
| Egg broken | 4 | 2 | 0 | 6 |
| Egg predated | 3 | 0 | 0 | 3 |
| Egg displaced | 0 | 0 | 0 | 0 |
| Crevice collapse | 0 | 0 | 0 | 0 |
| Dead adult in crevice | 1 | 0 | 0 | 1 |
| Number fledged (c) | 33 | 12 | 27 | 72 |
| Small dead chick | 3 | 3 | 6 | 12 |
| Chick disappeared | 25 | 11 | 12 | 48 |
| Chick predated | 1 | 0 | 0 | 1 |
| Large dead chick | 0 | 2 | 0 | 2 |
| Hatching success (b/a) | 0.79 | 0.85 | 0.85 | 0.82 |
| Fledging success (c/b) | 0.53 | 0.43 | 0.60 | 0.53 |
| Reproductive success (c/a) | 0.42 | 0.36 | 0.51 | 0.44 |

**Table 2.** Least Auklet productivity from plots on Kiska and Buldir islands in 2009.

| | Lava Dome | Old Lava 'Low' | Old Lava 'High' | Kiska Total | Buldir[1] |
|---|---|---|---|---|---|
| n (a) | 78 | 33 | 53 | 164 | 85 |
| Number hatched (b) | 62 | 28 | 45 | 135 | 74 |
| Number fledged (c) | 33 | 12 | 27 | 72 | 63 |
| Hatching success (b/a) | 0.79 | 0.85 | 0.85 | 0.82 | 0.87 |
| Fledging success (c/b) | 0.53 | 0.43 | 0.60 | 0.53 | 0.85 |
| Reproductive success (c/a) | 0.42 | 0.36 | 0.51 | 0.44 | 0.74 |

[1]Freeman et al. 2009. Biological monitoring at Buldir Island, Alaska in 2009: summary appendices. Report AMNWR 09/XX.

**Table 3.** Crested Auklet productivity and known causes of breeding failure as measured from three plots at Sirius Point, Kiska Island, Alaska in 2009.

| | Lava Dome | Old Lava 'Low' | Old Lava 'High' | Kiska Total |
|---|---|---|---|---|
| Crevices monitored, n (a) | 5 | 8 | 10 | 23 |
| Number hatched (b) | 3 | 8 | 10 | 21 |
| Egg abandoned | 0 | 0 | 0 | 0 |
| Egg disappeared | 1 | 0 | 0 | 1 |
| Egg broken | 1 | 0 | 0 | 1 |
| Egg predated | 0 | 0 | 0 | 0 |
| Egg displaced | 0 | 0 | 0 | 0 |
| Crevice collapse | 0 | 0 | 0 | 0 |
| Dead adult in crevice | 0 | 0 | 0 | 0 |
| Number fledged (c) | 2 | 6 | 4 | 12 |
| Small dead chick | 1 | 0 | 1 | 2 |
| Chick disappeared | 0 | 2 | 5 | 7 |
| Chick predated | 0 | 0 | 0 | 0 |
| Large dead chick | 0 | 0 | 0 | 0 |
| Crevice collapse | 0 | 0 | 0 | 0 |
| Hatching success (b/a) | 0.60 | 1.00 | 1.00 | 0.91 |
| Fledging success (c/b) | 0.66 | 0.75 | 0.40 | 0.57 |
| Reproductive success (c/a) | 0.40 | 0.75 | 0.40 | 0.52 |

**Table 4.** Crested Auklet productivity from plots on Kiska and Buldir islands in 2009.

| | Lava Dome | Old Lava 'Low' | Old Lava 'High' | Kiska Total | Buldir[1] |
|---|---|---|---|---|---|
| n (a) | 5 | 8 | 10 | 23 | 103 |
| Number hatched (b) | 3 | 8 | 10 | 21 | 98 |
| Number fledged (c) | 2 | 6 | 4 | 12 | 90 |
| Hatching success (b/a) | 0.60 | 1.00 | 1.00 | 0.91 | 0.95 |
| Fledging success (c/b) | 0.66 | 0.75 | 0.40 | 0.57 | 0.92 |
| Reproductive success (c/a) | 0.40 | 0.75 | 0.40 | 0.52 | 0.87 |

[1]Freeman et al. 2009. Biological monitoring at Buldir Island, Alaska in 2009: summary appendices. Report AMNWR 09/XX.

**Table 5a.** Number of Least Auklets banded at Sirius Point, Kiska Island, Alaska from 2001-2009.

| Year | Newly banded adults | Newly banded subadults | Within-year recaptures | Between-year recaptures | Total Captures |
|---|---|---|---|---|---|
| 2001 | 198 | 36 | 36 | - | 270 |
| 2002 | 20 | 1 | 0 | 5 | 26 |
| 2003 | 12 | 0 | 0 | 14 | 26 |
| 2007 | 114 | 12 | 22 | 20 | 168 |
| 2008 | 125 | 56 | 12 | 33 | 226 |
| 2009 | 53 | 51 | 4 | 31 | 139 |
| **Total** | **522** | **156** | **75** | **103** | **755** |

**Table 5b.** Number of Crested Auklets banded at Sirius Point, Kiska Island, Alaska from 2001-2009.

| Year | Newly banded adults | Newly banded subadults | Within-year recaptures | Between-year recaptures | Total Captures |
|---|---|---|---|---|---|
| 2001 | 23 | 4 | 2 | - | 29 |
| 2002 | 1 | 0 | 0 | 0 | 1 |
| 2003 | 6 | 0 | 0 | 0 | 6 |
| 2007 | 23 | 2 | 1 | 1 | 27 |
| 2008 | 41 | 9 | 4 | 6 | 60 |
| 2009 | 26 | 4 | 0 | 5 | 35 |
| **Total** | **120** | **19** | **7** | **12** | **158** |

**Table 6.** Comparison of CMR models from program MARK for Least Auklets at Sirius Point, Kiska Island, Alaska from 2001-2008, where $\phi$ is survival, *p* is the encounter probability and t is time. Adjusted for $\hat{c}$ = 2.197.

| Model | $QAIC_c$ | $\Delta QAIC_c$ | QAIC Weight | Model Likelihood | No. Parameters | Deviance |
|---|---|---|---|---|---|---|
| A $\{\phi_{(t)}\ p_{(grouped)}\}$ | 857.215 | 0.00 | 0.902 | 1.000 | 11 | 98.565 |
| B $\{\phi_{(t)}\ p_{(t)}\}$ | 861.652 | 4.44 | 0.098 | 0.109 | 16 | 92.796 |
| C $\{\phi_{(Year1+t)}\ p_{(grouped)}\}$ | 874.553 | 17.34 | <0.001 | <0.001 | 12 | 113.868 |
| D $\{\phi_{(.)}\ p_{(t)}\}$ | 877.324 | 20.11 | <0.001 | <0.001 | 10 | 120.706 |
| E $\{\phi_{(t)}\ p_{(.)}\}$ | 897.547 | 40.33 | <0.001 | <0.001 | 10 | 140.929 |
| F $\{\phi_{(.)}\ p_{(.)}\}$ | 919.185 | 61.97 | <0.001 | <0.001 | 3 | 176.699 |

**Table 7.** Least Auklet survival at Sirius Point, Kiska Island, Alaska - estimates ($\phi$) and encounter probabilities (*p*) for 2001-2008 as determined by model A from program MARK with confidence intervals adjusted for $\hat{c}$ = 2.197. Resight probability groups are A: 2002, 2003, 2004, 2008; B: 2005; C: 2006, 2007.

| | | | 95% Confidence Interval | |
|---|---|---|---|---|
| Parameter | Estimate | Standard Error | Lower | Upper |
| $\phi_{2001-2002}$ | 0.893 | 0.033 | 0.809 | 0.943 |
| $\phi_{2002-2003}$ | 0.946 | 0.028 | 0.858 | 0.981 |
| $\phi_{2003-2004}$ | 0.816 | 0.045 | 0.712 | 0.889 |
| $\phi_{2004-2005}$ | 0.725 | 0.067 | 0.578 | 0.836 |
| $\phi_{2005-2006}$ | 0.786 | 0.074 | 0.607 | 0.897 |
| $\phi_{2006-2007}$ | 0.913 | 0.066 | 0.676 | 0.981 |
| $\phi_{2007-2008}$ | 0.658 | 0.053 | 0.547 | 0.754 |
| $p_A$ | 0.936 | 0.016 | 0.896 | 0.961 |
| $p_B$ | 0.621 | 0.039 | 0.542 | 0.694 |
| $p_C$ | 0.818 | 0.049 | 0.701 | 0.896 |

**Table 8.** Comparison of CMR models from program MARK for Crested Auklets at Sirius Point, Kiska Island, Alaska from 2001-2008, where $\phi$ is survival, $p$ is the encounter probability and t is time. Adjusted for $\hat{c}$ = 1.137.

| Model | $QAIC_c$ | $\Delta QAIC_c$ | QAIC Weight | Model Likelihood | No. Parameters | Deviance |
|---|---|---|---|---|---|---|
| A {$\phi_{(Year1+t)}$ $p_{(grouped)}$} | 247.336 | 0.00 | 0.953 | 1.000 | 8 | 42.745 |
| B {$\phi_{(t)}$ $p_{(grouped)}$} | 253.566 | 6.23 | 0.042 | 0.044 | 9 | 46.798 |
| C {$\phi_{(t)}$ $p_{(t)}$} | 258.866 | 11.53 | 0.003 | 0.003 | 12 | 45.437 |
| D {$\phi_{(.)}$ $p_{(t)}$} | 259.947 | 12.61 | 0.002 | 0.002 | 7 | 57.512 |
| E {$\phi_{(.)}$ $p_{(.)}$} | 277.253 | 29.92 | <0.001 | <0.001 | 2 | 85.298 |
| F {$\phi_{(t)}$ $p_{(.)}$} | 279.644 | 32.31 | <0.001 | <0.001 | 8 | 75.053 |

**Table 9.** Crested Auklet survival at Sirius Point, Kiska Island, Alaska - estimates ($\phi$) and encounter probabilities ($p$) for 2001-2008 as determined by model A from program MARK with confidence intervals adjusted for $\hat{c}$ = 1.137. Resight probability groups are A: 2002, 2003; B: 2004, 2006, 2007, 2008; C: 2005.

| | | | 95% Confidence Interval | |
|---|---|---|---|---|
| Parameter | Estimate | Standard Error | Lower | Upper |
| $\phi_{Initial}$ | 0.783 | 0.050 | 0.671 | 0.865 |
| $\phi_{2002-2003}$ | 1.000 | <0.001 | 0.999 | 1.000 |
| $\phi_{2003-2004}$ | 1.000 | <0.001 | 0.999 | 1.000 |
| $\phi_{2004-2005}$ | 0.969 | 0.101 | 0.039 | 0.999 |
| $\phi_{2005-2006}$ | 0.905 | 0.114 | 0.423 | 0.992 |
| $\phi_{2006-2007}$ | 0.793 | 0.107 | 0.516 | 0.933 |
| $\phi_{2007-2008}$ | 0.732 | 0.129 | 0.429 | 0.908 |
| $p_A$ | 1.000 | <0.001 | 0.999 | 1.000 |
| $p_B$ | 0.920 | 0.032 | 0.829 | 0.965 |
| $p_C$ | 0.421 | 0.121 | 0.216 | 0.658 |

**Table 10.** Summary of Norway rat activity at eight wax block transect stations from 2006-2009 at Sirius Point, Kiska Island.

| Year | June Day 1 | June Day 2 | June Day 3 | July Day 1 | July Day 2 | July Day 3 | June Total | July Total | Grand Total |
|---|---|---|---|---|---|---|---|---|---|
| 2006 | 7 | 6 | 6 | 21 | 27 | 27 | 19 | 75 | 94 |
| 2007 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| 2008 | 2 | 3 | 7 | 5 | 6 | 14 | 12 | 25 | 37 |
| 2009 | 1 | 0 | 4 | 6 | 7 | 12 | 5 | 25 | 30 |

**Table 11.** Percent cover of dominant vegetation types in July 2009. Plot numbers refer to rat transect stations. Coordinates can be found in Eggleston and Jones (2006). OLH: Old Lava High, OLL: Old Lava Low, NL: New Lava.

| Plot | # | *Carex* | *Calamagrostis* | Moss/ Lichen | Fern | Bare Rock | *Puccinellia* | Dirt | *Poa* | Other |
|---|---|---|---|---|---|---|---|---|---|---|
| NL | 10 | 0% | 0% | 1% | 0% | 13% | 86% | 0% | 0% | 0% |
| NL | 15 | 0% | 0% | 31% | 0% | 9% | 60% | 0% | 0% | 0% |
| NL | 20 | 0% | 0% | 9% | 25% | 7% | 55% | 0% | 0% | 4% |
| NL | 25 | 0% | 0% | 10% | 16% | 3% | 57% | 0% | 0% | 14% |
| NL | 30 | 0% | 0% | 18% | 8% | 8% | 55% | 0% | 0% | 10% |
| NL | 35 | 0% | 0% | 12% | 8% | 14% | 63% | 0% | 0% | 4% |
| NL | 40 | 0% | 0% | 7% | 21% | 2% | 63% | 0% | 0% | 7% |
| NL | 45 | 0% | 0% | 26% | 1% | 5% | 64% | 0% | 0% | 4% |
| NL | 50 | 0% | 0% | 25% | 1% | 7% | 56% | 0% | 0% | 12% |
| NL | 55 | 0% | 0% | 26% | 13% | 9% | 44% | 0% | 0% | 8% |
| NL | 71 | 16% | 0% | 11% | 1% | 4% | 65% | 0% | 0% | 3% |
| NL | 72 | 0% | 0% | 10% | 10% | 7% | 71% | 0% | 0% | 3% |
| NL | 73 | 0% | 0% | 25% | 3% | 8% | 54% | 0% | 0% | 10% |
| NL | 74 | 5% | 0% | 16% | 0% | 10% | 66% | 0% | 0% | 3% |
| NL | 75 | 0% | 5% | 6% | 58% | 0% | 22% | 0% | 0% | 9% |
| NL | 76 | 11% | 0% | 21% | 21% | 10% | 34% | 0% | 0% | 3% |
| NL | 77 | 0% | 0% | 18% | 2% | 8% | 68% | 0% | 0% | 5% |
| NL | 78 | 0% | 0% | 15% | 4% | 6% | 69% | 0% | 0% | 6% |
| NL | 79 | 0% | 0% | 29% | 0% | 8% | 56% | 0% | 0% | 8% |
| NL | 80 | 0% | 0% | 12% | 39% | 6% | 37% | 0% | 0% | 6% |
| OLH | 31 | 68% | 0% | 8% | 14% | 2% | 0% | 3% | 2% | 4% |
| OLH | 32 | 23% | 4% | 8% | 52% | 4% | 0% | 1% | 0% | 10% |
| OLH | 33 | 31% | 18% | 19% | 19% | 3% | 0% | 4% | 0% | 7% |
| OLH | 34 | 41% | 3% | 12% | 39% | 0% | 0% | 1% | 0% | 5% |
| OLH | 35 | 31% | 32% | 14% | 16% | 1% | 0% | 1% | 1% | 5% |
| OLH | 36 | 8% | 21% | 0% | 63% | 0% | 0% | 1% | 0% | 8% |
| OLH | 37 | 65% | 1% | 4% | 28% | 0% | 0% | 0% | 0% | 2% |
| OLH | 38 | 27% | 13% | 20% | 36% | 0% | 0% | 0% | 0% | 4% |
| OLH | 39 | 72% | 4% | 7% | 15% | 0% | 0% | 0% | 0% | 2% |
| OLH | 40 | 41% | 20% | 11% | 24% | 0% | 0% | 0% | 0% | 5% |
| OLH | 51 | 11% | 14% | 42% | 15% | 0% | 0% | 14% | 0% | 4% |
| OLH | 52 | 0% | 16% | 16% | 34% | 4% | 0% | 14% | 11% | 4% |
| OLH | 53 | 8% | 21% | 25% | 12% | 1% | 0% | 4% | 26% | 4% |
| OLH | 54 | 3% | 55% | 18% | 5% | 2% | 0% | 8% | 5% | 5% |
| OLH | 55 | 11% | 8% | 10% | 57% | 0% | 0% | 3% | 1% | 10% |
| OLH | 56 | 14% | 12% | 29% | 22% | 4% | 0% | 11% | 4% | 4% |
| OLH | 57 | 1% | 22% | 15% | 43% | 1% | 0% | 12% | 1% | 5% |
| OLH | 58 | 9% | 49% | 4% | 29% | 0% | 0% | 2% | 0% | 8% |
| OLH | 59 | 26% | 0% | 14% | 41% | 1% | 0% | 10% | 1% | 8% |
| OLH | 60 | 17% | 14% | 13% | 42% | 1% | 0% | 4% | 4% | 5% |
| OLL | 41 | 18% | 35% | 0% | 37% | 3% | 0% | 0% | 0% | 7% |
| OLL | 42 | 90% | 0% | 2% | 1% | 2% | 0% | 0% | 0% | 4% |
| OLL | 43 | 54% | 26% | 0% | 18% | 0% | 0% | 0% | 0% | 2% |

| Plot | # | *Carex* | *Calamagrostis* | Moss/ Lichen | Fern | Bare Rock | *Puccinellia* | Dirt | *Poa* | Other |
|---|---|---|---|---|---|---|---|---|---|---|
| OLL | 44 | 45% | 24% | 8% | 14% | 4% | 0% | 0% | 0% | 6% |
| OLL | 45 | 0% | 43% | 2% | 47% | 0% | 0% | 1% | 0% | 7% |
| OLL | 46 | 24% | 10% | 8% | 47% | 2% | 0% | 1% | 1% | 8% |
| OLL | 47 | 44% | 30% | 7% | 15% | 0% | 0% | 0% | 0% | 4% |
| OLL | 48 | 16% | 41% | 13% | 23% | 2% | 0% | 0% | 0% | 6% |
| OLL | 49 | 31% | 10% | 14% | 19% | 12% | 0% | 1% | 3% | 10% |
| OLL | 50 | 27% | 8% | 9% | 26% | 1% | 0% | 4% | 0% | 24% |

**Table 12.** Summary of vegetation cover on the three plots at Sirius Point, Kiska Island in July 2009. OLH: Old Lava High, OLL: Old Lava Low, NL: New Lava.

| Plot | *Carex* | *Calamagrostis* | Moss/Lichen | Fern | Bare Rock | *Puccinellia* | Dirt | *Poa* | Other |
|---|---|---|---|---|---|---|---|---|---|
| OLH | 25% | 16% | 14% | 30% | 1% | 0% | 5% | 3% | 5% |
| OLL | 35% | 23% | 6% | 25% | 3% | 0% | 1% | 0% | 8% |
| NL | 2% | 0% | 16% | 12% | 7% | 57% | 0% | 0% | 6% |

## *Figures*

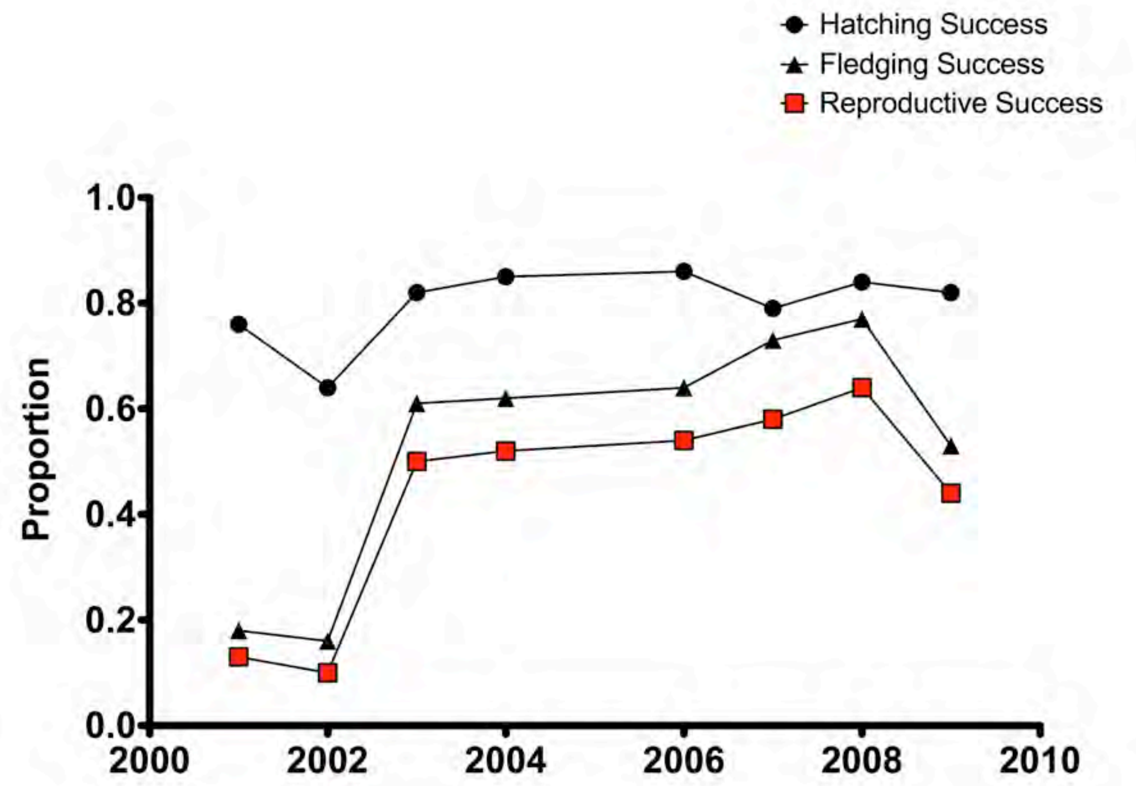


Figure 1. Hatching, fledging and overall reproductive success of Least Auklets at Sirius Point, Kiska Island, Alaska, from 2001-2009.

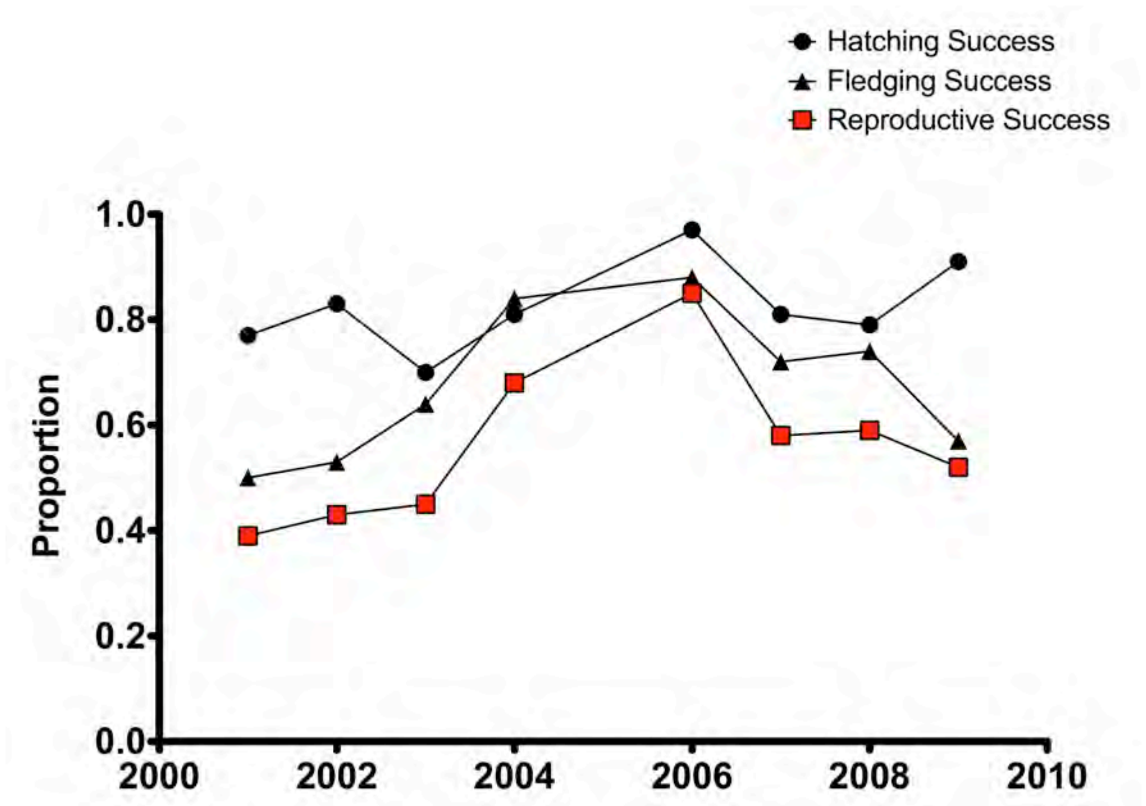


Figure 2. Hatching, fledging and overall reproductive success of Crested Auklets at Sirius Point, Kiska Island, Alaska, from 2001-2009.

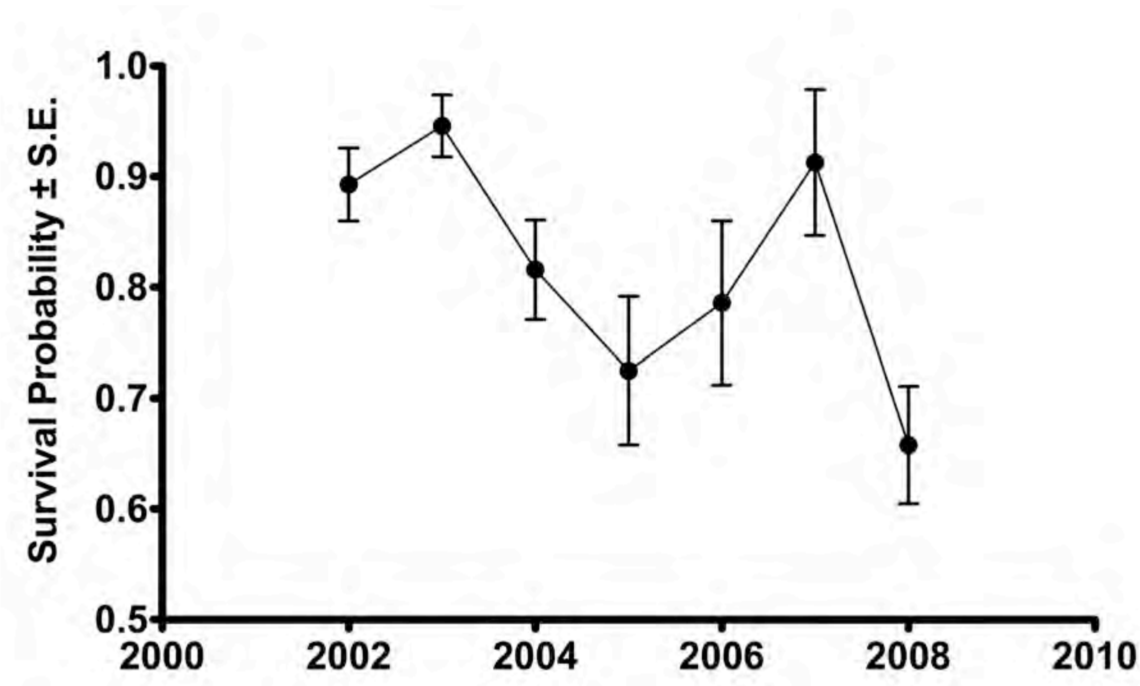


Figure 3. Apparent interannual survival estimates (± standard error) for Least Auklets at Sirius Point, Kiska Island, Alaska. Estimates are presented for the year following marking (i.e., 2002 represents survival from 2001-2002) and were derived from the top-ranked model using Program MARK.

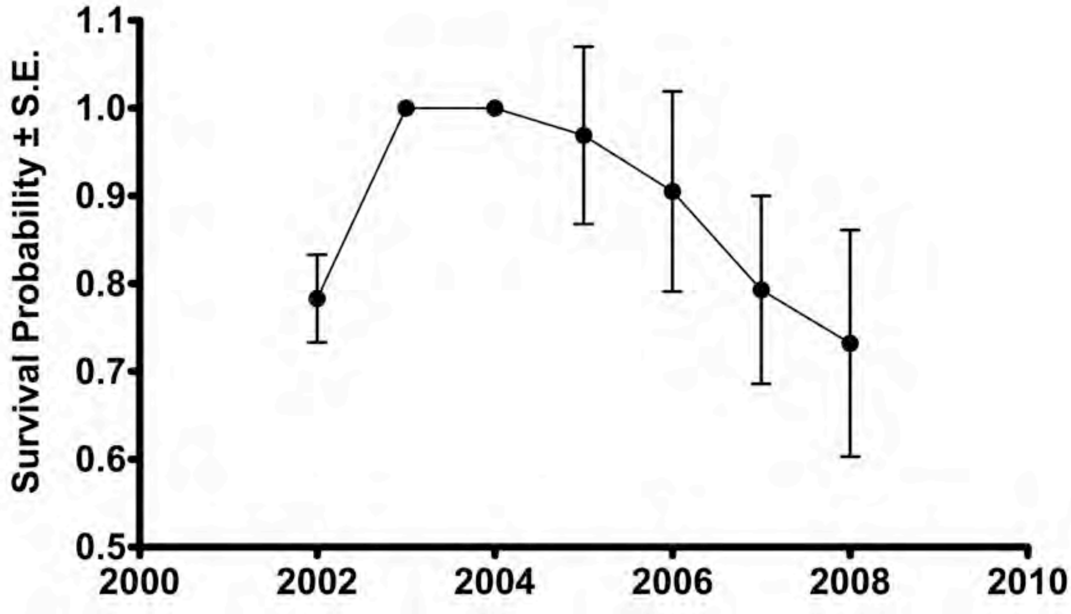


Figure 4. Apparent interannual survival estimates (± standard error) for Crested Auklets at Sirius Point, Kiska Island, Alaska. Estimates are presented for the year following marking (i.e., 2002 represents survival from 2001-2002) and were derived from the top-ranked model using Program MARK.

## *Appendices*

### *Appendix I*

List of birds recorded at Sirius Point from 27 May – 08 August 2009. Confirmed or suspected breeding species are indicated with an asterisk.

***Aleutian Cackling Goose** *Branta hutchinsii leucopariea* – Large flocks frequently observed over Sirius Point and roosting on the south side of Kiska Volcano (nests on southern part of Kiska).

***Common Eider** *Somateria mollissima v-nigrum* – Both males and females present at Sirius Point on numerous occasions through the summer, and ducklings present on at least three occasions.

***Green-winged Teal** *Anas crecca crecca* – Common at Christine Lake.

***Greater Scaup** *Aythya marila* – Common at Christine Lake.

***Common Merganser** *Mergus merganser* – A few were observed at Christine Lake

***Red-breasted Merganser** *Mergus serrator* – Uncommon at Christine Lake; one male and one female observed at Sirius Point in early June.

**Laysan Albatross** *Phoebastria immutabilis* – Uncommon off Sirius Point.

**Short-tailed Shearwater** *Puffinus teniurostris* – Uncommon off Sirius Point.

**Northern Fulmar** *Fulmaris glacialis* – Uncommon off Sirius Point; one dead individual, likely killed by Peregrine Falcon, found in Glen Larry in May.

***Leach's Storm-petrel** *Oceanodroma leucorhoa* – Uncommon at Sirius Point, heard at camp during one night in June. Suspected breeder?

***Fork-tailed Storm-petrel** *Oceanodroma furcata* – Uncommon at Sirius Point, heard occasionally at night from camp. Suspected breeder; breeds on Little Kiska?

***Pelagic Cormorant** *Phalacrocorax pelagicus* – Common, breeds locally.

***Red-faced Cormorant** *Phalacrocorax urile* – Uncommon, breeds locally.

***Bald Eagle** *Haliaeetus leucocephalus* – Common breeder. Less abundant than in 2007 or 2008.

***Peregrine Falcon** *Falco peregrinus* – Uncommon local breeder. One nest above camp fledged one chick.

***Rock Ptarmigan** *Lagopus mutus* – Uncommon on volcano slopes.

**Black-legged Kittiwake** *Rissa tridactyla* – Common, breeds locally.

***Parasitic Jaeger** *Stercorarius parasiticus* – Uncommon breeder in the Lake District

***Glaucous-winged Gull** *Larus glaucescens* – Common, breeds locally. Many more loafing, probably non-breeding birds present this year than in 2007 or 2008; over 50 counted on several occasions. At least two chicks were observed among large flocks of older birds in early August.

**Common Murre** *Uria aalge* – Uncommon off Sirius Point, breeds locally. One individual found dead from the winter on I-Can Beach in late May. Murre vocalizations were heard above Wolf Point during our hike to and from the Lake District in late July/early August.

**Thick-billed Murre** *Uria lomvia* – Both species breed locally (Pillar Rock). Murre vocalizations were heard above Wolf Point during our hike to and from the Lake District in late July/early August.

**Pigeon Guillemot** *Cepphus columba* – Rare, off Sirius Point (breeds locally?).

***Parakeet Auklet** *Aethia psittacula* – Uncommon breeder at Sirius Point.

***Least Auklet** *Aethia pusilla* – Abundant breeder at Sirius Point.

***Crested Auklet** *Aethia cristatella* – Abundant breeder at Sirius Point.

**Horned Puffin** *Fratercula corniculata* – Rare off Sirius Point.

***Tufted Puffin** *Fratercula cirrhata* – Uncommon off Sirius Point, breeds locally (Wolf Point and Little Kiska).

**Common Raven** *Corvus corax* – Two birds occasionally at Sirius Point, and almost daily from late July until the end of the season.

***Winter Wren** *Troglodytes troglodytes* – Common breeder.

***Song Sparrow** *Melospizia melodia aleutica* – Single individuals seen on several occasions throughout the summer, and up to five seen in late July and early August; possible post-breeding dispersal from Little Kiska.

***Lapland Longspur** *Calcarius lapponicus* – Common in alpine meadows, at Christine Lake, and on the old lava flow.

***Snow Bunting** *Plectophenax nivealis* – Uncommon breeder.

***Gray-crowned Rosy-finch** *Leucosticte tephrocotis* – Common breeder.

### *Appendix II*

Summary of Norway rat signs observed at Sirius Point in 2009 (LeAu: Least Auklet; CrAu: Crested Auklet).

| Date | Location | Comments |
|---|---|---|
| 30-May | Camp | 1 LeAu adult, < 1 week old |
| 31-May | Glen Larry | 1 CrAu egg, 4 LeAu eggs |
| 05-June | I-can Beach | LeAu adult |
| 06-June | New Lava | 1 CrAu egg, 3 LeAu adults, including 2 from the same crevice |
| 09-June | Camp | Rat caught in snap trap |
| 10-June | Camp | Rat caught in snap trap |
| 11-June | New Lava | 1 LeAu egg |
| 11-June | Old Lava Low | Cache #1: 2 LeAu adults, 2 CrAu eggs; near transect station 42 |
| 11-June | Old Lava Low | 1 LeAu egg |
| 12-June | New Lava | 2 LeAu eggs |
| 14-June | Old Lava Low | 1 LeAu egg |
| 14-June | Glen Larry | 1 LeAu egg |
| 15-June | Old Lava Low | 1 LeAu egg |
| 17-June | New Lava | 1 LeAu adult in crevice L337 |
| 19-June | New Lava | 1 LeAu egg |
| 29-June | Glen Larry | 1 LeAu egg, 1 LeAu adult |
| 30-June | New Lava | 1 LeAu egg |
| 30-June | New Lava | Cache #2: 2 LeAu adults, 2 LeAu eggs |
| 01-July | New Lava | 1 LeAu egg |
| 02-July | Survival Plot | 1 LeAu egg |
| 06-July | Survival Plot | 1 LeAu egg |
| 06-July | Camp Beach | 3 LeAu eggs, 2 CrAu eggs |
| 11-July | New Lava | 1 LeAu egg |
| 11-July | Glen Larry | 1 LeAu egg |
| 12-July | New Lava | 1 LeAu adult |
| 12-July | New Lava | Cache #3: 3 LeAu adults, 4 LeAu eggs |
| 13-July | New Lava | 1 CrAu egg |
| 14-July | Old Lava Low | 1 LeAu egg |
| 14-July | Glen Curly | 2 LeAu eggs, 1 LeAu chick |
| 16-July | Glen Curly | Cache #4: 1 LeAu egg, 1 LeAu adult |
| 17-July | New Lava | 1 LeAu egg |
| 18-July | Camp | Rat caught in snap trap |
| 22-July | New Lava | Cache #5: 3 LeAu adults, 1 LeAu egg |
| 23-July | New Lava | Fresh rat droppings on path to blind |
| 24-July | Camp Beach | 1 LeAu fledgling |
| 27-July | Camp | Rat caught in snap trap |
| 28-July | Glen Larry | 5 LeAu fledglings |
| 29-July | Glen Larry | 1 CrAu adult, 3 LeAu fledglings |
| 29-July | Old Lava High | Chew marks at stations 40 and 60 at the bottom of transects |
| 30-July | Glen Larry | 2 LeAu fledglings |
| 01-August | Christine Lake | Fresh rat tracks on beach, no rats caught at camp |
| 02-August | Glen Larry | 2 LeAu fledglings |
| 05-August | New Lava | 1 LeAu fledgling |