Survival and productivity of auklets (*Aethia* spp.) at Sirius Point, Kiska Island in 2007 in relation to the abundance and distribution of introduced Norway rats (*Rattus norvegicus*)

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October 2007

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Cover photo: Least Auklet Aethia pusilla by ALB.

Introduction

Introduced Norway rats (*Rattus norvegicus*) present a likely threat to the large auklet (*Aethia* spp.) colony at Sirius Point, Kiska Island, Aleutian Islands, Alaska. In the course of our ongoing study (2001-present), auklet productivity and survival, rat distribution and diet (hoards, predated adults, chicks and eggs) have been extensively quantified to help determine the scale and significance of rat impacts (see Major 2004, Eggleston and Jones 2006). The cumulative picture from of past studies is that auklets' productivity fails when rats are abundant at Sirius Point but that in most years unknown factors cause rats to be scarce. Comparisons of rat ecology at Sirius Point and at Christine, East and West Kiska Lakes (hereafter 'Lake District'), an area free of nesting auklets approximately seven kilometres to the south, were detailed by Eggleston and Jones (2006) and Major et al. (2007). In this report, we present survival and productivity data for auklets, and abundance and distribution of Norway rats at Sirius Point in 2007.

In summary, the objectives of our study were: 1) to quantify Least (*Aethia pusilla*) and Crested Auklet (*A. cristatella*) productivity from representative areas of the Sirius Point colony for the 2007 breeding season, 2) to identify causes of auklet breeding failure in 2007 (especially if involving rats), 3) to quantify Least and Crested Auklet adult survival at one study plot for 2001-2007 (again assessing possible effects of rats), 4) redeploy a rat monitoring transect protocol (first used in 2006) to quantify inter-year abundance of rats at Sirius Point, and 5) identify the remaining key questions about rat impacts on seabirds at Kiska.

Methods

Auklet Productivity

Least and Crested Auklet productivity was measured at Sirius Point, Kiska Island (52°08'N 177°37'E) using standardized United States Fish and Wildlife Service (USFWS) protocols (USFWS 2000). Any failed crevice was closely examined to determine the cause of failure, including whether rat predation was responsible. These data were compared to similar data collected at auklet colonies at Buldir (52°23'N 175°55'E) and Kasatochi Islands (52°11'N 175°31'W) using the same protocol. Buldir

and Kasatochi have no rats, and act as a useful comparison to Sirius Point in determining the effect of rats on auklet productivity.

Jones et al. (2001) and Major et al. (2006) described the three productivity plots 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. Data from 2001-2003 were presented by Major et al. (2006), and those from 2004-2006 by Eggleston and Jones (2006); here, we report comparisons between Sirius Point, Kasatochi and Buldir Islands for 2007.

Auklet Survival

Least and Crested Auklet adult interannual survival was measured using field procedures described in Jones (1992) and program MARK (White and Burnham 1999). The survival plot is thought to be representative of the colony (Jones et al. 2001), but this has not been tested. Because few new birds have been added to the marked population since 2002, we made a major effort to trap and colour-mark new individuals this year. Each captured adult individual was banded with a FWS stainless steel band on its right leg and fitted with a unique combination of Darvik plastic colour bands (two on left leg, one on right leg) as described by Jones et al. (2001). Resightings of banded birds occurred during peak auklet activity (approximately 1000-1530 hrs and 2300-0000 hrs) from 29 May to 28 July 2007. Previous estimates of adult survival were reported by Major et al. (2006) for 2001-2003, and Eggleston and Jones (2006) for 2003-2005.

Adult interannual survival estimates up to the period 2005-2006 are presented here, as the 2006-2007 survival estimate will not be available until 2008. Amongst our candidate models were those that included a 'transient effect' of marked individuals leaving the study area following banding (models C $\{\phi_{(Year1*t)}\ p_{(t)}\}$ and D $\{\phi_{(Year1*.)}\ p_{(t)}\}$), and one that sought to reduce the number of estimated parameters by grouping similar encounter probabilities (model A $\{\phi_{(t)}\ p_{(grouped)}\}$, as well as time-dependent and time-independent models of both survival and encounter probability (Table 8). Model selection was based on quasi-likelihood adjusted Akaike's Information Criteria ($QAIC_c$).

Norway Rat Abundance and Distribution

A new protocol for measuring annual variation in abundance and distribution of Norway rats was described by Eggleston and Jones (2006). Because snap-trapping is not feasible at Sirius Point, detection using chew marks at stations set across the auklet colony was recommended. Following this protocol, wax blocks enclosed in plastic tunnels were set at the same stations and along the same transect lines used by Eggleston and Jones (2006). Eighty stations (8 transects of 10 stations 25m apart) covered representative habitat types of the Sirius Point auklet colony. Two replicate monitoring trials were carried out, with one during 08-13 June and another during 09-14 July.

Additional Observations

A list of bird species identified from 27 May – 03 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

Auklet Productivity

Least Auklet hatching success did not differ significantly between plots ($\chi^2_2 = 6.59$, $p = 0.16$) so data were pooled (Table 1). A total of 173 crevices were followed, and of these, 137 (79%) hatched. The majority of egg loss (37%) was from eggs that disappeared without obvious evidence of predation or hatching, such as shell fragments, or chicks found at a later date. Eleven eggs (31% of crevices that failed) were found predated by rats, the most found in a single season at Sirius Point. Hatching success at Kiska did not differ significantly from Buldir (87%; Anderson and Freeman 2007) or Kasatochi (78%; Drummond and Larned 2007; Table 5).

Similarly, fledging success did not differ between plots ($\chi^2_2 = 3.82$, $p = 0.15$), and data were pooled such that of the 137 crevices that produced a hatched chick, the chick survived to a fledging age in 101 of them (73%). As with previous years, disappearing chicks accounted for the majority of post-hatching crevice failure (28 cases, 78%), and an

additional 7 (19%) were found dead, two of which were obviously predated by rats (6%). Fledging success was similar across all three islands (Table 5).

Overall reproductive success was the same across plots ($\chi^2_2 = 6.59$, $p = 0.16$), and was the highest recorded during the present study (2001-present, at 58%). Again, there was no statistical difference between Buldir (66%; Anderson and Freeman 2007), Kasatochi (61%; Drummond and Larned 2007) and Kiska Islands in overall reproductive success in 2007.

Among the crevices followed, we could estimate hatch dates for 69 based on the standard protocols (USFWS 2000). Mean hatch date did not vary across plots, and was 01 July ± 7.3 days. Mean hatch on Buldir was 27 June ± 7.8 days (Anderson and Freeman 2007).

Productivity data for Crested Auklets (n = 36) are presented in Table 3. Because of small sample sizes, data were pooled across the three plots. Of the four Crested Auklet crevices found on the New Lava plot, none produced any hatched chicks. Overall, hatching success was 81%, similar to both Kasatochi (87%; Drummond and Larned 2007) and Buldir (91%; Anderson and Freeman 2007). Fledging success (72%), however, was significantly lower than Buldir (93%; Anderson and Freeman 2007), and lower than Kasatochi (88%; Drummond and Larned 2007). And finally, overall reproductive success was 58%, which was significantly lower both than Buldir (85%; Anderson and Freeman 2007) and Kasatochi (76%; Drummond and Larned 2007).

Auklet Survival

For the first time since 2001, a substantial number of individuals were added to the marked population of Least Auklets. In total, 114 adults were newly banded in 2007 and an additional 20 were recaptured following banding in previous years.

The most parsimonious model included survival rate varying by year and with years grouped for similar encounter probabilities (model A, Table 7). This served to reduce the number of parameters estimated while maintaining precision in the estimate of those parameters. Under this model, survival for the period 2005-2006 was 0.674 (95% C.I.: 0.490-0.817) and encounter probability was grouped with that from 2002 (0.929). Table

7 presents the candidate models, while the results of model A are presented in Table 8 and Figure 2.

Norway Rat Abundance and Distribution

Rat activity in 2007 was low at the same stations compared to 2006. In June, no rats were detected using wax blocks, as compared to 18 in June 2006, and but one detection was found in July (75 in 2006). The only detection in July 2007 was in Glen Curly at 160m asl (transect station #63).

On 05 July, seven wind-killed Least Auklet adults were placed near rat transect stations along Glen Larry (#24-30) to determine whether rats would scavenge dead birds. On 08 July, two of the auklets had breast muscle eaten, but were otherwise untouched.

Discussion

The 2007 season had the highest reproductive success for Least Auklets recorded on Kiska during 2001-2007. This coincided with a year of extremely low rat abundance at Sirius Point (see below). Paradoxically, a higher proportion of breeding failure was attributed to rat predation in 2007 compared to previous years. The high proportion of predated eggs detected in 2007 was likely a function of the amount of time spent searching for the cause of breeding failure, or the ability of the investigators to properly identify rat-predated eggs and chicks.

The similarities between Buldir, Kasatochi and Kiska in productivity suggest that Norway rats had little overall effect on the breeding success of Least Auklets in 2007, and that other processes (density-dependence, oceanography) were more likely to limit productivity. The lack of a complete auklet breeding failure since 2002 and increase in productivity during 2003-2007 may imply a cyclical pattern in rat abundance, and consequently, predation pressure on auklets, with 2007 being at, or near the bottom of such a cycle.

In contrast to the high observed productivity, adult annual survival for the period 2005-2006 was the lowest recorded from Kiska since 2001, and lower than that reported by Jones et al (2002) from Buldir, although 95% confidence intervals (wide for Kiska) do overlap. As encounter probability was high in 2006 (similar to 2002, 0.929 ± 0.023), we

believe this estimate to be robust. In 2005, few days were spent at Sirius Point (Eggleston and Jones 2005) because of logistical reasons, and as such, a low encounter probability was expected. A survival estimate for the period 2006-2007 will not be available until after resighting occurs in 2008, however many subadults were recorded on the banding plot (>50% of birds in some cases), which may foretell a high survival rate for 2006-2007.

Over the period 2001-2006, apparent interannual survival was inversely related to reproductive success, although this is not significant ($r = -0.48$, $P = 0.52$). Major (2004) suggested that for 2001-2003 this was the result of the increased mortality costs associated with raising young through the entire breeding season, and provided further evidence that the reduced productivity observed in 2001 and 2002 was not driven by poor food supply, as poor survival rates in Least Auklets from Buldir Island in 1993 and 1999, for example, were known to be linked to poor oceanographic conditions (Jones et al. 2002).

Qualitatively, 2007 was the year of the lowest apparent rat abundance and activity (ILJ), and quantitatively, rats were significantly scarcer as detected by wax blocks compared with 2006. The methods developed and implemented by Eggleston and Jones (2006) have inherent upper and lower bounds of detection, so while rats were present at Sirius Point in 2007, they were present below the detection levels of the wax block method in June, and detected minimally in July. Since identical procedures were used in 2006 and 2007, the comparison of relative abundance of rats would appear to be valid. Would that we had had such a protocol in place since 2001 – the data from this would have been invaluable for monitoring changing rat abundance. In 2007, no rat sign was detected at the higher elevations either along transects or on productivity plots on Bob's Plateau (4 transects, Old Lava Low and Old Lava High productivity plots), and the majority of rat sign was confined to either the valleys (Glen Larry, Glen Curly, Glen Mo) or the new lava dome. Yet even at the camp location, once rats were lethally trapped, activity decreased, further suggesting that abundance was very low.

In addition, rats were detected on the New Lava productivity plot, but not at either Old Lava plot. As there was no difference between the three in hatching, fledging or overall reproductive success, we can conclude that Norway rats had a minimal impact on

auklet breeding success in 2007, and were present at severely decreased numbers compared with previous years.

Interestingly, we found that rats would scavenge breast muscle from dead auklets, which had not, until now, been documented at Sirius Point. The auklet carcases were placed in such a manner as to prevent scavenging by avian predators (i.e. under rocky overhangs or in shallow crevices), confirming the source of predation as rats. Auklet carcasses were previous seen to persist without being scavenged (2001 and 2002).

Additional Observations

A pair of Song Sparrows (*Melospiza melodia*) bred successfully at Sirius Point for the first time since at least 1996, fledging one chick. The fledgling and female quickly dispersed following breeding, but the male remained and continued singing through the summer. Song Sparrows were previously thought to have been extirpated from Kiska by rats (Jones et al. 2001), so it is interesting that the sparrows have (re-?) appeared after five years of low rat abundance.

Three Glaucous-winged Gull (*Larus glaucescens*) nests were located near camp; one with two eggs, another with three, and an empty nest bowl. This is the first evidence of gull nesting at the Sirius Point auklet colony. The two-egg nest (Nest 1) was abandoned as determined by standing the eggs point-up for several days. Of the three eggs in the other nest (Nest 2), two hatched on 18 June, and one chick survived to approximately 20 days when it disappeared and adults no longer actively defended the nest site. Eggs were measured to the nearest 0.1mm using vernier callipers. Since all clutches were complete upon discovery, A-, B- and C-eggs were not determined. Eggs in Nest 1 measured 78.0mm x 52.9mm and 73.2mm x 53.5mm. In Nest 2, eggs were 81.5mm x 50.3mm, 78.1mm x 50.7mm and 75.7mm x 50.0mm, all of which are larger than the means reported for this species in British Columbia (Verbeek 1993). In addition, on one occasion, an adult Glaucous-winged Gull landed on the banding plot and consumed food regurgitated by a previously-captured Least Auklet that remained on the rocks.

In late July and early August, three Common Eider (*Somateria mollissima*) females and seven ducklings were seen almost daily in Tangerine Cove swimming in the kelp or resting on the rockweed towards Parakeet Point.

One Peregrine Falcon (*Falco peregrinus*) nest was located above the camp, the young hatched near 15 June. Two other Peregrine Falcon nests were located near Steam Beach and the kittiwake colony towards Wolf Point, and both had adults actively defending a nest site.

Winter Wrens (*Troglodytes troglodytes*) were scarce compared with previous years (ILJ) but still bred successfully at Sirius Point. Several singing males were found in early-mid June, one fledgling was found dead through the summer (see below) and another seen near camp in mid July.

A strong night of south/southeast winds killed several birds in Glen Larry including one adult Glaucous-winged Gull, seven adult Least Auklets, one Crested Auklet, one adult Grey-crowned Rosy-finch, two adult and one fledgling Winter Wrens and an adult female Snow Bunting. Muscle samples were taken from the songbirds for the USFWS tissue bank in Anchorage, and feather samples were collected from the auklets for stable isotope analysis. On 25 July, after a night of heavy fog and light winds (ca. 15 kt.), one adult Crested Auklet, one adult and nine fledgling Least Auklets, two adult Glaucous-winged Gulls and one adult and one fledgling Winter Wren were discovered in the same location.

Finally, heavy winds on the night of 29/30 July killed one adult and three fledgling Crested Auklets, six adult and 71 fledgling Least Auklets, two adult Grey-crowned Rosy-finches, one adult Snow Bunting and one adult and ten fledgling Winter Wrens. The deaths of large numbers of Winter Wrens by wind in 2007 were an inexplicable and previously unrecorded phenomenon.

Conclusions and Recommendations

1. Norway rat abundance was qualitatively the lowest, and Least Auklet productivity the highest recorded since 2001.
2. Rats were present, but at levels mostly below the detection limit of the wax block method described in Eggleston and Jones (2006).

3. Adult survival for 2005-2006 was low as for recent years, but 2006-2007 may prove to be fairly high as the resighting of birds was high this year.
4. More information on factors affecting interannual survival needs to be collected or compiled to explain the recent decrease in Least Auklet survival.
5. An integrated approach including diet analysis and demography of auklets and diet analysis and factors affecting rat distribution and abundance needs to be taken.
6. Factors regulating over-winter survival and distribution of rats need further investigation.

Acknowledgements

We thank Grant Samson and Michelle Wille for assistance in the field, Lisa Scharff and Jeff Williams for support and guidance throughout the season, Stephan Lorenz for assistance in program MARK, and the captain and crew of the M/V *Tiglax* for logistical support and transportation. This ongoing study of rats and auklets at Kiska is made possible entirely by the generous funding provided by AMNWR.

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Table 1. Least Auklet productivity and known causes of breeding failure as measured from three plots at Sirius Point, Kiska Island in 2007.

	Lava Dome	Old Lava 'Low'	Old Lava 'High'	Kiska Total
Crevices monitored, n (a)	80	39	54	173
Number hatched (b)	61	33	43	137
Egg abandoned	1	2	6	9
Egg disappeared	6	2	5	13
Egg broken	1	1	0	2
Egg predated	10	1	0	11
Egg displaced	0	0	0	0
Crevice collapse	0	0	0	0
Dead adult in crevice	1	0	0	1
Number fledged (c)	50	22	29	101
Small dead chick	0	1	4	5
Chick disappeared	10	9	9	28
Chick predated	1	1	0	2
Large dead chick	0	0	1	1
Hatching success (b/a)	0.76	0.85	0.80	0.79
Fledging success (c/b)	0.82	0.67	0.67	0.73
Reproductive success (c/a)	0.63	0.56	0.54	0.58

Table 2. Least Auklet productivity from plots on Kiska, Buldir and Kasatochi in 2007.

	Lava Dome	Old Lava 'Low'	Old Lava 'High'	Kiska Total	Buldir[1]	Kasatochi[2]
n (a)	80	39	54	173	68	124
Number hatched (b)	61	33	43	137	59	97
Number fledged (c)	50	22	29	101	45	76
Hatching success (b/a)	0.76	0.85	0.80	0.79	0.87	0.78
Fledging success (c/b)	0.82	0.67	0.67	0.73	0.76	0.78
Reproductive success (c/a)	0.63	0.56	0.54	0.58	0.66	0.61

1: Anderson and Freeman 2007, 2: Drummond and Larned 2007.

Table 3. Crested Auklet productivity and known causes of breeding failure as measured from three plots at Sirius Point, Kiska Island in 2007.

	Lava Dome	Old Lava 'Low'	Old Lava 'High'	Kiska Total
Crevices monitored, n (a)	4	15	17	36
Number hatched (b)	0	13	16	29
Egg abandoned	1	1	0	2
Egg disappeared	1	1	0	2
Egg broken	1	0	1	2
Egg predated	1	0	0	1
Egg displaced	0	0	0	0
Crevice collapse	0	0	0	0
Dead adult in crevice	0	0	0	0
Number fledged (c)	0	11	10	21
Small dead chick	0	0	0	0
Chick disappeared	0	2	6	8
Chick predated	0	0	0	0
Large dead chick	0	0	0	0
Hatching success (b/a)	0.00	0.87	0.94	0.81
Fledging success (c/b)	0.00	0.85	0.63	0.72
Reproductive success (c/a)	0.00	0.73	0.59	0.58

Table 4. Crested Auklet productivity from plots on Kiska, Buldir and Kasatochi in 2007.

	Lava Dome	Old Lava 'Low'	Old Lava 'High'	Kiska Total	Buldir[1]	Kasatochi[2]
n (a)	4	15	17	36	66	143
Number hatched (b)	0	13	16	29	60	124
Number fledged (c)	0	11	10	21	56	109
Hatching success (b/a)	0.00	0.87	0.94	0.81	0.91	0.87
Fledging success (c/b)	0.00	0.85	0.63	0.72	0.93	0.88
Reproductive success (c/a)	0.00	0.73	0.59	0.58	0.85	0.76

1: Anderson and Freeman 2007, 2: Drummond and Larned 2007.

Table 5. Comparisons of hatching, fledging and reproductive success in Least and Crested Auklets from Buldir, Kasatochi and Kiska Islands.

		Hatching Success			Fledging Success			Reproductive Success		
Species	Islands	χ^2	df	p	χ^2	df	p	χ^2	df	p
Least	Kiska-Buldir	0.736	1	0.39	0.053	1	0.82	0.970	1	0.32
Auklet	Kiska-Kasatochi	0.013	1	0.91	0.205	1	0.65	0.148	1	0.70
Crested	Kiska-Buldir	1.099	1	0.29	4.742	1	0.03	8.576	1	<0.01
Auklet	Kiska-Kasatochi	0.414	1	0.52	2.909	1	0.09	4.263	1	0.04

Table 6a. Number of Least Auklets banded at Sirius Point from 2001-2007.

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
Total	**344**	**49**	**58**	**39**	**490**

Table 6b. Number of Crested Auklets banded at Sirius Point from 2001-2007.

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
Total	**53**	**6**	**3**	**1**	**63**

Table 7. Comparison of CMR models from program MARK for Least Auklets on Kiska from 2001-2007, where ϕ is survival, p is the encounter probability and t is time.

Model	$QAIC_c$	$\Delta QAIC_c$	QAIC Weight	# Parameters	Deviance
A $\{\phi_{(t)}\ p_{(grouped)}\}$	597.156	0.00	0.839	9	41.387
B $\{\phi_{(t)}\ p_{(t)}\}$	601.189	4.03	0.111	11	41.317
C $\{\phi_{(Year1*t)}\ p_{(t)}\}$	602.852	5.70	0.049	11	42.980
D $\{\phi_{(Year1*2)}\ p_{(t)}\}$	616.084	18.93	< 0.001	8	62.359
E $\{\phi_{(.)}\ p_{(t)}\}$	617.782	20.63	< 0.001	7	66.096
F $\{\phi_{(t)}\ p_{(.)}\}$	640.517	43.36	< 0.001	7	88.832
G $[\phi_{(.)}\ p_{(.)}\}$	665.644	68.49	< 0.001	2	124.082

Table 8. Least Auklet survival estimates (ϕ) and encounter probabilities (p) for 2001-2006 as determined by model A from program MARK with confidence intervals corrected for c-hat = 1.847.

			95% Confidence Interval	
Parameter	Estimate	Standard Error	Lower	Upper
$\phi_{2001\text{-}2002}$	0.896	0.031	0.819	0.943
$\phi_{2002\text{-}2003}$	0.935	0.027	0.857	0.972
$\phi_{2003\text{-}2004}$	0.792	0.042	0.698	0.863
$\phi_{2004\text{-}2005}$	0.749	0.083	0.556	0.877
$\phi_{2005\text{-}2006}$	0.674	0.086	0.490	0.817
$p_{2002+2006}$	0.929	0.023	0.868	0.963
$p_{2003+2004}$	0.961	0.017	0.909	0.984
p_{2005}	0.507	0.078	0.357	0.655

Figures

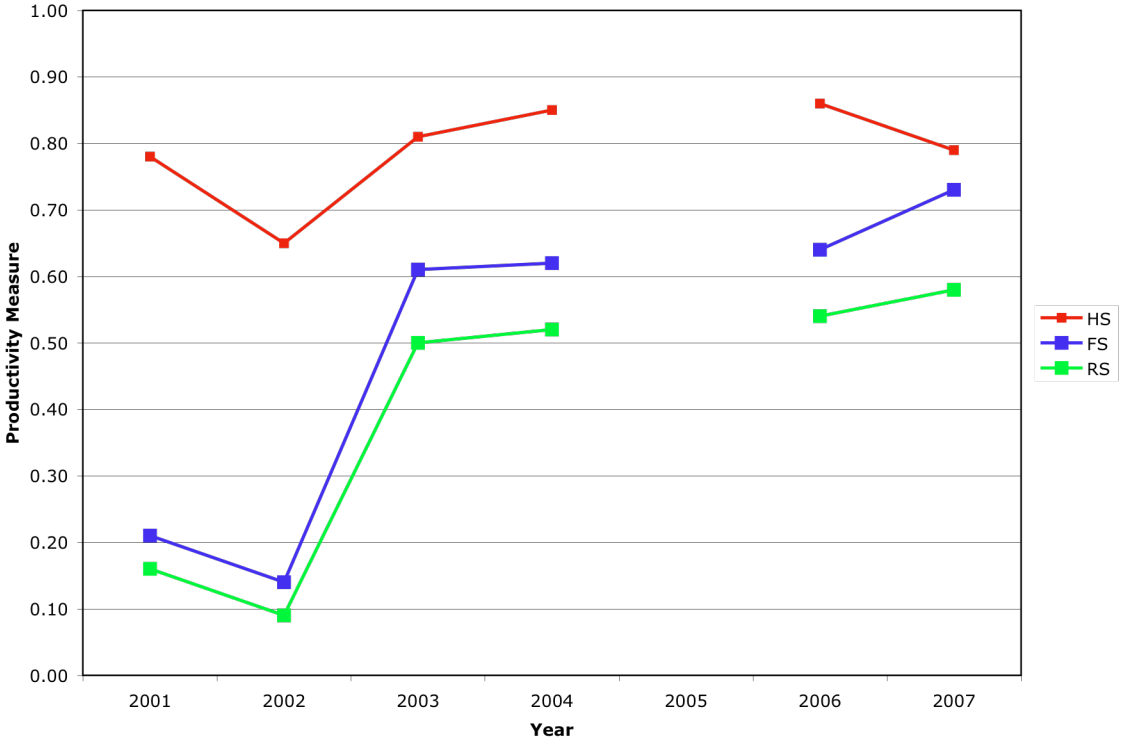

Figure 1. Hatching (HS), fledging (FS) and overall reproductive success (RS) of Least Auklets at Sirius Point, Kiska Island, Alaska from 2001-2007.

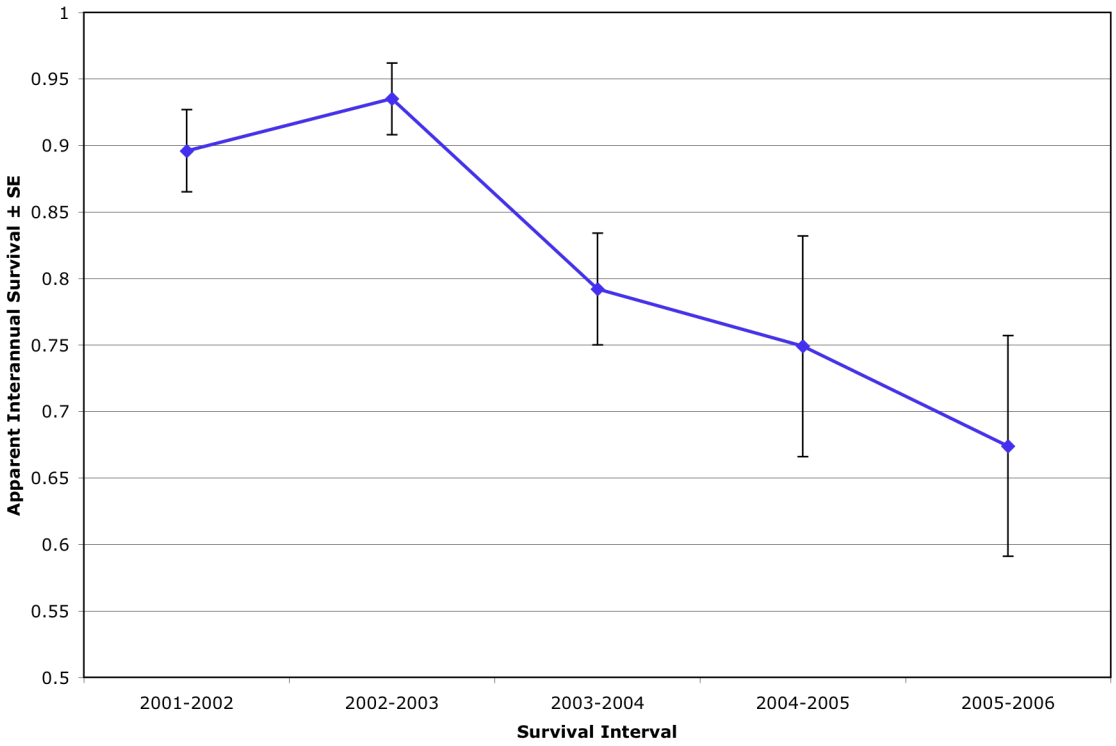

Figure 2. Apparent interannual survival probabilities for Least Auklets at Sirius Point, Kiska Island, Alaska from 2001-2006 as estimated by model A (Table 7) from program MARK.

Appendix I. List of birds recorded at Sirius Point in 2007. Confirmed or suspected breeding species are indicated in boldface. Species recorded from the Lake District are reported in Jones and Wille (2007).

Aleutian Cackling Goose *Branta hutchinsii* – Large flocks common over Sirius Point, breeds south of West Kiska Lake.

Common Eider *Somateria mollissima* – three hens and seven ducklings at Sirius Point in late July/early August.

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

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

Northern Fulmar *Fulmaris glacialis* – Uncommon off Sirius Point.

Leach's Storm-petrel *Oceanodroma leucorhoa* – Rare, heard on three nights at camp. Breeds on Little Kiska?

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.

Peregrine Falcon *Falco peregrinus* – Uncommon local breeder.

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

Glaucous-winged Gull *Larus glaucescens* – Common, three nests near camp.

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

Murre spp. *Uria* spp. – Both species breed locally (Pillar Rock), species not confirmed.

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

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

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

Least Auklet *Aethia pusilla* – 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)

Northern Raven *Corvus corax* – Two birds regularly at Sirius Point.

Winter Wren *Troglogytes troglodytes* – Common breeder.

Lapland Longspur *Calcarius lapponicus* – Common in alpine meadows.

Snow Bunting *Plectrophenax nivalis* – Uncommon breeder.

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

Song Sparrow *Melospiza melodia* – One pair breeding at Sirius Point, male remained and sung through mid-July.

Appendix II. Summary of Norway rat signs observed at Sirius Point in 2007 (LeAu: Least Auklet; CrAu: Crested Auklet).

Date	Location	Comments
May-August	Camp	Fresh tracks almost daily near camp, especially noticeable after rain events or heavy fog
27 May	Camp	Arrival, no droppings in cabin, rats apparently scarce
29 May	Glen Curly	Cache #1: 2 LeAu eggs, 1 CrAu egg, 1 LeAu adult; fresh droppings
30 May	Camp	Adult LeAu with brain/eyes eaten
31 May	New Lava Dome	Predated LeAu egg and fresh droppings on survival plot
04 June	New Lava Dome	Predated LeAu egg in productivity crevice
05 June	Glen Larry	LeAu adult with breast muscle, eyes and brain eaten
06 June	New Lava Dome	Predated LeAu adult near blind
07 June	Glen Larry	Predated LeAu adult and egg
08 June	Glen Mo	Predated LeAu adult and egg
08 June	New Lava Dome	Predated LeAu adult and egg along rat transect
09 June	New Lava Dome	Two LeAu adults, 2 LeAu eggs predated (incl. two productivity crevices)
12 June	Glen Curly	Predated LeAu egg near transect station #68
13 June	Glen Curly	Cache #2: 1 subadult LeAu, 10 LeAu eggs; near transect station #67
14 June	New Lava Dome	Predated LeAu adult
18 June	New Lava Dome	Predated LeAu adult in productivity crevice
24 June	New Lava Dome	Two predated LeAu eggs
27 June	Glen Mo	Two predated LeAu adults
27 June	Glen Curly	Three predated LeAu eggs, and one near transect station #62
08 July	Glen Curly	Predated LeAu adult near transect station #63
08 July	Glen Larry	Two adult LeAus (of seven) placed near transect stations had pectoral muscle eaten.
11 July	Glen Curly	Predated LeAu adult between transect stations #62/63. Brain and pectoral muscle eaten
12 July	Glen Curley	Predated LeAu adult between transect stations #62/63 (different from 11 July adult)
13 July	Glen Mo	Predated LeAu adult
25 July	Camp	Female rat caught in snap trap (291mm, 126g)
27 July	Camp	Male rat caught in snap trap (294mm, 123g)
30 July	New Lava Dome	LeAu fledgling killed by wind impact had brain/eye eaten; LeAu fledger predated