

**AN ASSESSMENT OF THE EVIDENCE FOR NORWAY RAT (*RATTUS NORVEGICUS*)  
EFFECTS ON CRESTED AUKLETS (*AETHIA CRISTATELLA*) AT SIRIUS POINT, KISKA  
ISLAND, ALASKA FROM 2001-2009**

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Norway rats (*Rattus norvegicus*) were introduced to Kiska Island (52°08'N, 177°37'E) sometime between 1941-1946 (Murie 1959). Following the removal of introduced Arctic foxes (*Alopex lagopus*) in 1987 (Deines and McClellan 1987a, b), biologists became aware of the potentially large effect the rats might be having on breeding Least (*Aethia pusilla*) and Crested Auklets (*Aethia cristatella*) at a large colony at Sirius Point, the northern tip of the island. During 2001-2008, researchers from Memorial University of Newfoundland have conducted field studies on the effect of rats on auklet demography (survival and reproductive success) as well as diet, and produced publications evaluating effects of rats on the Least Auklet population (Major *et al.* 2006; Major *et al.* 2007). To date, the focus has been on Least Auklets; this report summarizes the evidence of the effect of rats may be having on Crested Auklets at Sirius Point from 2001-2008.

There is less information on rat predation of Crested Auklets than Least Auklets because: 1) the Sirius Point colony contains 80% Least and only 20% Crested Auklets (Jones and Hart 2006), so Crested Auklet nest crevices were inherently less likely to be sampled; 2) Crested Auklets also 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; 3) 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 – subsequent work took place on these same plots even though sites of higher Crested Auklet densities have been located.

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 neither 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. Theoretically, Crested Auklet chicks could be at greater risk of rat predation than Least Auklets at Sirius Point because Crested Auklet eggs and chicks have more nest-days of rat exposure. Crested Auklet eggs are incubated for 33-36 days (Fraser *et al.* 1999) compared to 30-32 days for Least Auklets (Roby and Brink 1986; Piatt *et al.* 1990). Crested Auklet chicks remain nest-bound for 34 days (Fraser *et al.* 1999), while Least Auklets fledge after 28 days (Roby and Brink 1986).

While our monitoring efforts provided little direct evidence of rat predation on Crested Auklet chicks, our sample sizes of Crested Auklet crevices monitored for reproductive performance were very low (range 23-36 / year; Table 1). However, Crested Auklet reproductive success (number of chicks fledged per egg laid) was correlated with

Least Auklet reproductive success at Kiska Island (correlation coefficient: 0.63,  $p < 0.08$ ), indicating that similar factors are likely affecting the reproductive success of both species. Rat distribution was very uneven at Sirius Point, with many more rats on lower elevations and the 1964 lava dome (Bond and Jones 2008). Very few Crested Auklet nests have been monitored in this area (total for all 2001-2009 = 42), and in five of these years, **no chicks fledged**. In total, only eight Crested Auklet chicks fledged in monitored crevices on the 1964 lava dome since 2001 (Table 2). This evidence leads us to believe that rat predation or disturbance in this area could be a significant cause of Crested Auklet reproductive failure.

Crested Auklet reproductive success has been monitored on three islands in the Aleutian Islands – Buldir, Kiska and Kasatochi islands (Buchheit and Ford 2008; Bond and Jones 2009; Freeman *et al.* 2009). Overall, reproductive success differed among islands from 2001-2009 (Generalized Linear Model,  $p = 0.033$ ), with significantly fewer (0.09) chicks fledged/pair on Kiska than on either other island (Bonferroni corrected multiple comparisons,  $p < 0.05$ ). Jones (in prep.) has been developing a population effects model for Crested Auklets and rats at Kiska Island. As a preliminary estimate, rats were assumed to result in a decrease of 0.05 chicks fledged per egg laid overall at Sirius Point as compared with rat-free colonies (Buldir and Kasatochi islands). Based on the data summarized above, it would appear that this estimate is conservative.

Rat abundance has been extremely variable at the auklet colony at Sirius Point during 2001-2009 (Major *et al.* 2006; Bond and Jones 2008, 2009) with the high rat abundance years 2001 and 2002 corresponding with nearly complete breeding failure of Least Auklets and the lowest reproductive success of Crested Auklets during our study. The open question remaining is the frequency of these years of high rat abundance and auklet breeding failure. A population viability analysis for Least Auklets indicates that with more than 2 years of high rat abundance and corresponding breeding failure out of ten years, the colony will decline by 63% over the next 20 years (Major *et al.* submitted); we do not have the necessary demographic information to run similar models for Crested Auklets at this time.

In four years of monitoring rat abundance and distribution quantitatively, rats were detected more often in the Gullies than other plots (generalized linear model,  $p < 0.001$ ), and there was no difference in detections between the 1964 lava dome and Bob's Plateau ( $p = 0.27$ ). Bob's Plateau is a large 1 km<sup>2</sup> area where auklet productivity is also monitored (Eggleston and Jones 2006; Bond and Jones 2008). There were also significantly more rat detections in July than in June ( $p = 0.001$ ). Rats have not been detected above 200 m above seal level (Major and Jones 2005; Eggleston and Jones 2006; Bond and Jones 2007, 2008). The crevices used to monitor Crested Auklet reproductive success on Bob's Plateau range from 65-156 m above sea level, or within the range of altitudes at which rats have been observed or detected.

In a detailed analysis of rat diet using stable-isotope analysis, Major *et al.* (2007) found that Crested Auklets made up to 40% of rat diet at Sirius Point, slightly less than the estimated proportion of Least Auklets in the rats' diet, but a significantly greater proportion than terrestrial or marine vegetation or invertebrates. Based on stable-isotope analysis,

auklets present in the diet of rats could be both adult and chick in origin. Inferences about the predation of adult Least Auklets early in the breeding season (May) have been made from the contents of rat caches found mostly in 2001 and 2002. These caches resulted from hungry rats discovering returning auklets and caching these at a location for future consumption. Crested Auklet eggs, but not adults, were found frequently in these caches. We believe the low number of Crested Auklet adults in caches was a result of the low proportion of Crested Auklets in the Sirius Point colony and their relatively high body mass (260g, Jones 1993a), which would make them difficult for a rat to drag from a crevice to a cache site. In general, rat caching of auklets is an ephemeral phenomenon, occurring in early spring, and reflects only a small indicator of rat predation on auklets at Sirius Point.

Taken together, this evidence, although limited, indicates that there may be a significant effect of rat predation on Crested Auklets at Sirius Point; further study would only serve to clarify the exact magnitude of this relationship.

**Table 1.** Crested Auklet Reproductive Success at Sirius Point, Kiska Island

Year	n	Hatch	Fledge	HS	RS
2001	31	24	12	77%	39%
2002	23	19	10	83%	43%
2003	20	14	9	70%	45%
2004	31	25	21	81%	68%
2005	-	-	-	-	-
2006	34	33	29	97%	85%
2007	36	29	21	81%	58%
2008	29	23	17	79%	59%
2009	23	21	12	91%	52%

\*HS: Hatching success = # eggs hatched / # eggs laid; RS: Reproductive success = # chicks fledged / # eggs laid. No monitoring occurred in 2005.

**Table 2.** Crested Auklet Reproductive Success on the 1964 Lava Dome at Sirius Point, Kiska Island

Year	n	Hatch	Fledge	HS	RS
2001	6	2	1	33%	17%
2002	5	3	0	60%	0%
2003	3	0	0	0%	0%
2004	5	4	0	80%	0%
2005	-	-	-	-	-
2006	5	4	3	80%	60%
2007	4	0	0	0%	0%
2008	4	3	0	75%	0%
2009	5	3	2	60%	40%

\*HS: Hatching success = # eggs hatched / # eggs laid; RS: Reproductive success = # chicks fledged / # eggs laid. No monitoring occurred in 2005.



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