Auklet demography and Norway Rat distribution and abundance at Sirius Point, Kiska Island, Aleutian Islands, Alaska in 2001

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Norway rats (*Rattus norvegicus*) were introduced to Kiska Island, western Aleutian Islands, Alaska during the 1940s (Murie 1959). Rats are presently widespread on the island and conspicuous evidence of rat predation on Least and Crested Auklets has been found by Alaska Maritime National Wildlife Refuge (AMNWR) biologists that have visited the large auklet colony at Sirius Point (52°08'N 177°37'E) during June and August 1996 (ILJ and Jeff Williams, personal observations) and June 2000 (Art Sowls and Mark Rauzon personal observations). Introduced Norway Rats are known to have caused declines at or extirpated colonies of small seabird species (e.g., Ancient Murrelets at Langara Island, Queen Charlotte Islands, British Columbia, Gaston 1994) by predating adults, their eggs and nestlings. Thus the auklet colony at Sirius Point may currently be threatened by rat predation. Kiska Island had introduced Arctic Foxes, which were present at Sirius Point until March 1986 when they were eradicated using compound 1080 (Deines and McClellan 1986). The impact of former fox populations on rats is unknown but they probably had a controlling effect, especially in winter when few other prey would have been available. The effect the persisting rat population may be having on auklet population dynamics at Sirius Point is of concern and needs to be quantified. This was the principal objective of the present study. The situation at Sirius Point is of particular concern because this location contains the largest auklet colony in the Aleutian Islands and possibly Alaska.

Norway rats could cause auklet population declines by killing adults (reduction in adult survival), and lowering productivity by predating eggs (reduction of hatching success), and nestlings (reduction in fledging success). To assess the impact of rats on auklets at Kiska, auklet productivity and survival need to be measured and compared to islands free of introduced mammalian predators. Protocols for measuring these auklet population parameters have been developed and employed at other Aleutian Islands by AMNWR (e.g., US Fish and Wildlife Service 1996). Long term monitoring of auklet survival and productivity is ongoing at Main Talus, Buldir (52°23.266' N 175°55.029' E, 10+ years) and Kasatochi Islands (52°10.751' N 175°31.183' W, 5 years) where there are no rats. Buldir Island has never had any introduced mammalian predators but has breeding Glaucous-winged Gulls, an auklet predator. Buldir is located about 100 km west of Sirius Point and offers the best opportunity to obtain comparative data on auklet population parameters at a rat-free colony. Kasatochi

Island had introduced Arctic foxes that were removed in 1980-1986 and currently has some Glaucous-winged Gulls. We propose to have this study continue for three breeding seasons (2001-2003) to account for annual variability in population parameters arising from various factors at each site.

Methods

Auklet productivity

We monitored Least and Crested Auklet productivity using standardized procedures (US Fish and Wildlife Service 1996). We located and monitored 210 Least and 30 Crested Auklet crevices on three study plots (Figure 1, Table 1). The first productivity study plot 'New Lava' was on the top and east side of the 1965-69 lava dome (Miller et al. 1998) near our camp in Tangerine Cove (52°08.049'N 177°35.789'E) with all crevices within 60 m of the coastline and about 25-30 m elevation. The second plot 'Old Lava Low' was in the valley between the 1965-69 lava dome and Bob's Plateau (52°07.803'N 177°35.731'E), 520 m from the coastline and at about 100 m elevation. The third plot 'Old Lava High' was at the top of Bob's Plateau close to the base of a steep talus slope of block lava on the side of Kiska volcano (52°07.699'N 177°36.167'E), an 80 minute hike from camp, at 800 m from the coastline and at about 180 m elevation. We believe the habitat at the three study plots provided a representative sample of auklet crevices at the Sirius Point colony, in terms of distance from the sea and vegetative cover. The New Lava plot was sparsely vegetated with lichens, the Old Lava Low plot was heavily vegetated with *Carex*, *Calamagrostis* sp. and fern overgrowing basalt blocks, and the Old Lava High plot was moderately vegetated with *Carex* and fern. To evaluate the effect of rats on auklet productivity at Sirius Point, estimates of hatching and fledging success were compared statistically to data from Buldir (1990-2000 and 2001-2003) and Kasatochi (1996-2000 and 2001-2003). We carefully checked each failed crevice for signs of rat predation of adults, eggs and nestlings.

Auklet banding and adult survival

We propose to quantify Least and Crested Auklet adult survival using field procedures developed by Jones (1992a) and the analysis program MARK (White and Burnham 1999). Least and Crested were captured during June and July using noose

carpets set on the colony surface within a single 50 m^2 study area. Noose carpets are believed to select breeding and non-breeding auklets randomly from the population (Jones 1992a). Each captured adult auklet was given a numbered stainless steel leg band and a unique combination of three plastic color bands. Subadult birds were given a steel band only. Upon capture, birds were measured according to the standard protocols (Jones and Montgomerie 1992, Jones 1993, Jones et al. 2000). We took a small (c. 0.1 mL) blood sample from each adult Least Auklet for genetic sexing purposes (Fridolfsson and Ellegrin 1999). Regular observations were made from a blind during the auklets daily activity period to resight surviving marked birds. Resightings were used to estimate within season survival in 2001. Resightings during 2002 and 2003 will be required to obtain an estimate of annual adult survival comparable to the auklet colony at Buldir. It will be important to know the sex of each individual in the marked population because if, for example, rats differentially predated one sex the effect on population would be more significant than equal mortality of both sexes.

Extent of Sirius Point auklet colony

The full geographical extent of the auklet colony at Kiska has not been previously quantified. We explored the colony (as indicated by occupied crevices, bird activity and droppings on surface) on foot and recorded the colony boundaries using GPS equipment. We established a 200 m survey grid and recorded vegetation cover, talus depth, dominant rock size, substrate characteristics, estimated auklet density (orders of magnitude, 0, 1-10, 10-100 or >100 occupied crevices per 100 m^2 based on droppings, vocalizations, numbers of birds on surface and ILJ's intuition) and took photographs at most stations. Taken together, these data were used to construct a map of the occupied area on a georeferenced version of the USGS topographical map (Fig. 2). We also visited nine surface-count plots set up in the 1980s and estimated the proportion of each 100 m^2 plot covered by grasses (*Calamagrostis* and *Poa* spp.), sedges *Carex* spp., fern, lichen & moss, and bare rock to requantify vegetation cover as previously done in 1987 (Deines and McClellan 1987).

Norway Rat occurrence/density

We quantified rat activity geographically by looking for and recording evidence of rats (fresh and weathered droppings, disturbance of indicator devices) and rat predation on auklets (predated eggs, carcasses with braincase and eyes chewed out) throughout the colony and especially at survey stations on the 200 m grid. We believe our search for rat sign covered the extent of the auklet colony and provided a realistic indication of rat activity during June-July of 2001.

Results

Auklet productivity

Least Auklet hatching success at Kiska was 71.7% on the New Lava plot, 77.4 % on the Old Lava Low plot, and 81.0% on the Old Lava High plot (75.7% overall; Table 1). Most eggs that failed to hatch were abandoned. We found no direct evidence of rat predation of eggs from productivity crevices although 21 Least Auklet and 5 Crested Auklet eggs disappeared from their crevices without trace. There was no statistical difference in hatching success among productivity plots. Least Auklet fledging success was 22.9% on the New Lava plot, 7.3 % on the Old Lava Low plot, and 19.2% on the Old Lava High plot (Table 1). Most chicks that failed to hatch died at less than one week of age and we were able to examine most chick corpses to determine cause of death. We found no direct evidence of rat predation of auklet chicks. On the New Lava plot, we found the body of an adult Least Auklet, killed by rat bites to its neck, at the entrance of one crevice from which the chick had just disappeared. After the period of wind and rain on June 26-28, we found 23 Least auklet chicks that had died of exposure shortly after hatching. There was no statistical difference in hatching success ($\chi^2 = 0.3$, df = 2, P = 0.9), fledging success ($\chi^2 = 3.2$, df = 2, P = 0.2), or reproductive success ($\chi^2 = 3.0$, df = 2, P = 0.2) among productivity plots. Crested Auklet hatching success at Kiska was 77.4%, fledging success was 50.0%, and reproductive success 38.7% (Table 2). Our sample of Crested Auklet productivity crevices (n = 30) was too low to make any strong conclusions about causes of breeding failure.

There was no difference in Least or Crested Auklet hatching success among crevices monitored at Kiska, Buldir and Kasatochi (Table 3). Fledging and reproductive success of Least Auklets was substantially lower at Kiska than at the other colonies (Table 3).

Auklet banding and adult survival

We captured a total of 236 Least Auklets (200 adults and 36 subadults) and 26 Crested Auklets (22 adults and 4 subadults; Table 3) during June and July. Conditions for auklet banding were extremely poor during June when gale force winds and rain occurred on most days, delaying our attempts to establish a marked study population. For example, during the 17 day period between June 14-30, gale and storm warnings were forecast on 15 days and small craft advisories on the remaining two days. As a consequence, auklet surface activity was low on most days. On June 27, after a forecast of SE 40 knot winds we observed auklets being dashed to the ground by wind gusts and found 63 Least and 7 Crested Auklet carcasses within 30 m of the banding plot, all killed by crashing into rocks. Nevertheless we were able to reach our intended goal of 200 colour marked Least Auklets on July 22. Survival of Least Auklet chicks was very low, resulting in most adults departing the colony early this year so few colour marked birds visited the colony in July. Nevertheless, we observed 98 colour marked Least Auklets on at least one occasion after banding.

Extent of Sirius Point auklet colony

Based on our ground surveys, we determined that the Sirius Point auklet colony includes the following areas of Kiska Island: 1) the 1965-1969 Lava Dome (Miller et al. 1998) with the exception of the northwesternmost c.5% of its area, which is low lying and wave washed; 2) Bob's Plateau (an older lava dome forming a plateau of block lava mostly overgrown with grasses, sedge and ferns) east of the 1965-69 lava dome, occupied by auklets eastwards to within 200-300 m of the eastern edge of the plateau which is heavily overgrown; 3) Main Talus, a steep slope of sparsely vegetated block lava extending from the top of Bob's Plateau to about 400 m elevation, the upper limit of occupied crevices indistinct; 4) Glen Mo, a steep eroding slope of scattered boulders and rock outcrops in dense grass cover south of the 1965-69 Lava Dome; and 5) among boulders and on outcrops adjacent to Steam Beach (Figs. 1-2). The extent of the colony is limited along the east boundary of Bob's Plateau and Main Talus by extensive vegetation cover, above Main Talus by snow beds that remain into mid-June, and on the west side of Main Talus and Glen Mo by extensive vegetation cover. The eastern edge of the colony is 150-250 m west of the edge of Bob's Plateau, running north-south and roughly parallel to the edge of the plateau. Bob's Plateau had scattered patches of high

density (>100 crevices per 100m^2) occupied crevices, with low density (1-10 crevices per 100 m^2) in grassy areas. Parakeet Auklets nested along headlands along the steep front of Bob's Plateau, on the southeast and southwest edge of the 1965-69 Lava Dome at Steam Beach, and among boulders and on outcrops along the slopes southeast of Steam Beach.

Norway Rat occurrence/density

We found limited evidence of rat activity near Sirius Point during our time spent on Kiska in 2001 (summarized in Fig. 3, Appendix 1). In the colony area, with the exception of Steam Beach, few fresh rat droppings were seen before late July. For example, on the beach near camp on May 25 (two droppings), at the banding plot on the Lava Dome July 10 (one fresh dropping near the blind). We found many fresh and weathered droppings near the active fumarole north of Steam Beach July 1 (Fig. 3). In the colony area, weathered rat droppings, presumably from the winter of 2000-2001, were found beneath the large boulders near our camp in Tangerine Cove, near the active fumarole north of Steam Beach, and under large boulders along the south and east sides of Steam Beach. After mid-July, fresh rat droppings were found along the path between camp and steam beach, on the lava dome and old lava low productivity plot, and on survey stations on Bob's Plateau.

We found a total of 55 auklet carcasses (all Least Auklet) predated by rats. Most of these were in one cache found at the top of Bob's Plateau (52°07.660'N 177°36.217'E) on June 2. This contained 38 fresh Least Auklet carcasses, most with neck bites and chewed eyes and brains. No further signs of activity were noted at this cache (disturbance of carcasses, droppings etc.) and the bodies were mostly decomposed by early July. We made intensive searches in the area of the cache and found no droppings or any other signs of rat activity. We found no evidence of rat tunnels or droppings anywhere else on the grassy habitat of Bob's Plateau or nearby Hector's Valley until late July (Appendix 1). A second cache containing at least 4 partly decomposed Least Auklet carcasses was found at the fumarole near Steam Beach near the southwest end of the 1965-69 lava dome on July 13, with many fresh and weathered rat droppings found nearby. We found two fresh Least Auklet carcasses predated by rats near our auklet productivity plot on the 1965-69 lava dome, one near a failed crevice (see productivity section). We trapped two rats at snap traps set under our weatherport at camp July 21

(one specimen retained as voucher study skin), yet no fresh rat droppings were found near camp. We found no other evidence that rats were attracted to our camp area by the smell of our food supplies.

Of the 48 survey stations on the 200 m grid that we visited, rat sign was found at four: at 754-02, on the grassy west flank of Kiska Volcano, 80 m elevation, 170 m south of the colony boundary at Steam Beach (rat tunnels in grass), at 758-04, on the 1965-69 lava dome 170 m SW of camp, (skeletal remains in a red box set by Sowls and Rauzon in 2000), at 756-08 (small chick with brain eaten) and at 758-07 (adult with brain eaten).

Of the six wooden rat trap boxes found by us that had been placed on the northeast side of the lava dome by Art Sowls and Mark Rauzon in 2000, all had been chewed around the entrance hole by rats and all had the traps sprung. No box contained the carcass of a rat although one (on station 758-04) contained rat nasal bones, whiskers and fur.

Changes in vegetation cover on Bob's Plateau, 1986-2001

We found evidence that vegetation cover has increased significantly on the old lava dome forming Bob's Plateau. On nine plot surveyed in late June of both 1986 and 2001, on average, grass (*Calamagrostis* sp.) cover increased by 216%, ferns by 215% and *Carex* cover by 54% while bare rock decreased by 70% and mosses and lichen by 64% (Table 4).

Other observations

A list of bird species identified during fieldwork in 2001 is attached in Appendix 2.

Discussion

Auklet productivity

Auklet hatching success at Kiska in 2001 was similar to that measured at Buldir and Kasatochi, suggesting that few rats predated incubating adults or their eggs at Kiska in 2001. However, fledging success of Least Auklets was substantially lower at Kiska than either Buldir or Kasatochi, which recorded normal fledging success in 2001. The fledging success of 17.6% and reproductive success of 13.3% at Kiska were the lowest ever recorded for Least Auklets at any colony, to our knowledge. Breeding failure during chick rearing at Kiska most commonly resulted from the death of small chicks

due to exposure. We found no direct evidence of rats causing breeding failure, but in one case a rat-predated adult Least Auklet was found outside a crevice from which the chick had disappeared. Disappearance without trace of chicks from crevices would be consistent with rat predation but this occurred in only 33% of crevices that failed during chick rearing (Table 1). If rats reduced productivity, their effect would have been on chicks in crevices after mid July, when rats apparently became more abundant and widespread in the auklet colony (see below).

We considered three hypotheses to explain the cause of Least Auklet breeding failure at Kiska in 2001:

1) predation of adults and nestlings by rats.
2) death of small chicks due to bad weather early in chick rearing
3) poor oceanographic conditions leading to failure of adult provisioning and chick starvation

We were unable to reject hypothesis 1. Although we found little direct evidence of rats taking eggs, nestlings and adults from productivity crevices, rats did predate auklets in the colony and direct evidence at our sample of nests would have been extremely difficult to obtain. It is possible that death and disappearance of chicks from crevices was caused by predation and disturbance of brooding adults and removal of chicks from crevices by rats. If this was the case, it would appear that rats prefer Least Auklet adults and nestlings over Crested Auklets, as indicated by Crested Auklet's higher breeding success.

Hypothesis 2 may be rejected because Least Auklet fledging success was close to normal at Buldir and Kasatochi, which experienced similar bad weather to Kiska during late June 2001. It appears that whatever phenomenon caused breeding failure during chick rearing at Kiska was unique to this colony.

Assuming oceanographic conditions vary at a large geographic scale (e.g., Mantua et al. 1997), hypothesis 3 may be rejected because Buldir, Kiska and Kasatochi would be expected to experience similar conditions in the same year. Furthermore, Least Auklet fledging success was close to normal at Buldir and Kasatochi, which presumably experienced similar abundance of copepods and other auklet prey to Kiska. Chick meals collected at Kiska in 2001 appeared to contain the usual volume of *Neocalanus* copepods (ILJ). Further examination and comparison of chick diet among Kiska, Buldir and Kasatochi could shed further light on the question of the role of oceanography in

causing the 2001 breeding failure. Our impression from direct observations of auklets feeding close to Sirius Point was that parents were not experiencing difficulties in chick provisioning in 2001.

Additional productivity data from Kiska, Buldi and Kasatochi from more breeding seasons will be required to determine whether Least Auklet breeding failure in 2001 was a unique event or a general tendency for this large colony.

Auklet banding and adult survival

Resighting in future years of auklets color-marked in 2001 will provide robust estimates of adult survival that will be comparable to rat free colonies. Rat predation of adults occurred on our study plot in 2001 (one predated adult found). It will be very important to determine whether adult survival rates at Kiska are normal or depressed compared to other colonies. Within season survival in 2001 was probably high, but quantification of this was hampered by breeding failure and departure of most of the Least Auklet local population early in the season.

Extent of Sirius Point auklet colony

The size and geographical extent of the auklet colony at Sirius Point are large. The 1965-69 lava dome supports the highest breeding density of auklets, mostly of more than 100 occupied crevices per 100 m^2. Bob's plateau, which is probably an older lava dome (c. 100-150 years, Miller et al. 1998) now extensively overgrown by vegetation, also supports large numbers of birds, probably mostly 10-100 occupied crevices per 100 m^2. However, plant succession is occurring rapidly on this area, as indicated by striking increases in plant cover between 1986 and 2001. Much of Bob's Plateau may be unsuitable for auklet breeding in another 15-30 years. We were unable to locate an occupied area described by Deines and McClellan (1987) as 'a very small old lava flow or talus slope east of the main colony'. Possibly this area has disappeared due to encroaching vegetation.

Expansion of the auklet colony is limited by snow cover on otherwise suitable block lava habitat above 300 m elevation on the slopes of the volcano, and by lack of suitable habitat to the east and west of the present colony site. In the long term, the persistence of a large colony at Sirius Point will require further volcanic activity. Fortunately, based

on recent recorded activity of Kiska volcano (Miller et al. 1998), more auklet habitat is likely to appear soon.

How large is the auklet colony at Sirius Point, Kiska? Estimating numbers of crevice nesting seabirds is notoriously difficult because most nests are invisible and numbers of adults visible vary unpredictably (Jones 1992b). Nevertheless, Day et al. (1979) estimated the size of the Kiska colony as at least 1,160,000 Least Auklets and 230,000 Crested Auklets but concluded the total population could be much larger. Based on the observed occupied colony surface area of 1.8 km^2 and an estimated average density of 50 occupied crevices per 100 m^2 of surface area, there would be about 900,000 occupied crevices or about 1.8 million breeding birds, about 1.44 million Least Auklets and 360,000 Crested Auklets. This estimate of average occupied crevice density is likely low, especially because of the structure of the 1965-69 lava dome, which comprises about 33% of the total colony surface and has extensive regions of porous lava with crevice density exceeding 1 occupied crevice per m^3 to a depth of more than 5 m (500 occupied crevices per 100 m^2 of surface area). For example, our banding plot at the northeast edge of the lava dome appears to be of low to moderate auklet density compared to the rest of the lava dome and has a surface area of 25 m^2, yet supports more than 100 occupied crevices as indicated by marked birds. An estimate of colony size of 3-6 million birds may be more realistic, making this the largest auklet colony in Alaska. The large size of the colony is no guarantee of its continued existence, because breeding failure and adult mortality caused by an introduced predator could cause rapid population declines. A large auklet colony at North Head close to Kiska Harbor, originally described by A.C Bent based on a visit about 1910 (Bent 1919), has disappeared.

Norway Rat occurrence/density

Based on our observations, it appears that few rats were present on Sirius Point at the start of the breeding season, possibly because of poor winter survival (the winter of 2000-2001 was severe in the western Aleutians). Weathered droppings suggest that Steam Beach and the beach in Tangerine Cove were preferentially used by rats during the winter. These two areas are unusual in that they offer access to the inter-tidal zone. Most of the remainder of the colony site is bordered by steep sea cliffs. Fresh rat sign began to appear throughout the colony about mid-July. We speculate that this increase

in rat activity / abundance may be related to the appearance of independent young of the year.

The scarcity of evidence of rat predation on auklets was one of the most striking findings of our study. During more than 200 person days of work on the auklet colony we found only two caches of dead auklets. We found little fresh rat sign (droppings) in or near the auklet colony. These findings differ from observations of previous researchers. For example, on 23 August 1996 during a 5 h visit to Sirius Point, Jeff Williams and 12 others found: 1) 'rat droppings throughout the lava flow', 2) '11 (auklet) eggs which had evidence of rat predation', and 3) 'carcasses of 43 Least Auklets and 4 Crested Auklets which were attributed to rats'. In June 1988, Hector Douglas and others found four caches of 27, 8, c.20 and c.8 Least Auklets, two on Bob's Plateau and two on the Lava Dome adjacent to the location of our camp in 2001. These observations suggest that rats were more abundant in other years. However, even in 2001, rat activity was probably mostly occurring below ground where we were unable to check. Further work is required to evaluate the impact of rats on Least Auklets at their largest colony.

Conclusions

1. Norway Rats were present on much of the auklet colony at Sirius Point, Kiska Island, and preyed on Least Auklet adults and nestlings.
2. Least Auklets experienced very low (13%) reproductive success (mainly due to chick loss) at Sirius Point compared to rat-free auklet colonies(Buldir 55%, Kasatochi 55%) monitored in 2001 and previous years; chick loss was consistent with rat activity but little direct evidence of predation of monitored crevices was obtained.
3. Based on a sample of 30 monitored crevices, Crested Auklets experienced normal reproductive success (c.40%) compared to rat free colonies monitored in 2001 and previous years.
4. Norway Rat abundance in and near the auklet colony was lower during the 2001 breeding season relative to that in 2000, 1996 and probably 1988, as indicated by comparisons between our data and that of previous researchers.
5. The Steam Beach and Tangerine Cove areas adjacent to the 1965-69 lava dome were important rat wintering areas in 2000-2001.

6. Plant succession on the old lava area (Bob's Plateau), advancing from the north and east colony boundaries, is gradually rendering this area unsuitable for auklet breeding.
7. The auklet colony at Sirius Point, Kiska Island is very large, probably containing 3-6 million breeding individuals, about 80% Least Auklet and 20% Crested Auklet.
8. Monitoring of auklet productivity at Sirius Point for at least two more years is required before any definitive conclusions can be made about the impact of Norway Rats.
9. Monitoring of adult survival by resighting color marked birds at the study plot for two more years will be required to reveal rat impacts on annual adult survival rate; each individual should be sexed using the genetic technique to determine whether rats preferentially take one sex over the other.

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Table 1 Least Auklet productivity and known causes of breeding failure at Kiska Island in 2001

	Lava Dome	Old Lava low	Old Lava high	all
crevices monitored, n (a)	98	53	58	210
number hatched (b)	70	41	47	159
egg abandoned	18	3	5	26
egg disappeared	8	8	6	22
egg displaced from crevice	2	1	0	3
number fledged (c)	16	3	9	28
small chick died of exposure	41	19	26	86
chick disappeared	13	19	11	43
large dead chick, starved?	0	1	1	2
hatching success (b / a)%	71.4	77.4	81.0	75.7
fledging success (c / b)%	22.9	7.3	19.2	17.6
reproductive success (c / a)%	16.3	5.6	15.5	13.3

Table 2 Least Auklet productivity at Kiska, Buldir and Kasatochi Islands in 2001

	Kiska dome	old low	old high	Kiska all	Buldir	Kasatochi
n (a)	98	53	58	209	65	92
number hatched (b)	70	41	47	158	55	76
number fledged (c)	16	3	9	28	36	55
hatching success (b / a)	71.4	77.4	81.0	75.7	81.8	82.6
fledging success (c / b)	22.9	7.3	19.2	17.6	65.5	72.0
reproductive success (c / a)	16.3	5.6	15.5	13.3	55.3	55.0

Table 3 Crested Auklet productivity at Kiska, Buldir and Kasatochi Islands in 2001

	Kiska	Buldir	Kasatochi
n (a)	31	75	131
number hatched (b)	24	63	115
number fledged (c)	12	48	62
hatching success (b / a)	77.4	84.5	87.8
fledging success (c / b)	50.0	76.2	54.0
reproductive success (c / a)	38.7	64.0	45.0

Table 3 Auklet banding at Sirius Point, Kiska Island in 2001

Date	Least Auklet			Crested Auklet			day
	adults	subadults	total	adults	subadults	total	total
June 14	13	13	26	0	1	1	27
June 17	9	8	17	1	0	1	18
June 19	5	0	5	0	0	0	5
June 21	18	9	27	3	0	3	30
June 23	12	6	18	0	1	1	19
June 28	11	0	11	1	0	1	12
June 30	19	0	19	1	1	2	21
July 3	14	0	14	1	0	1	15
July 7	32	0	32	5	0	5	37
July 10	17	0	17	0	0	0	17
July 12	14	0	14	4	0	4	18
July 14	9	0	9	3	1	4	13
July 15	10	0	10	0	0	0	10
July 19	9	0	9	2	0	2	11
July 22	8	0	8	1	0	1	9
Total:	**200**	**36**	**236**	**22**	**4**	**26**	**262**

Table 4 Vegetation changes at surface count plots, Kiska Island 1986[1]-2001

Plot		Calamagrostis	Poa sp.	Carex sp.	fern	lichen & moss	bare rock	unidentified
1	1986	3	0	2	5	77	10	3
	2001	20	2	15	15	35	10	3
	% change	+567		+650	+200	-55	0	0
2	1986	4	0	2	3	85	5	1
	2001	30	0	2	30	35	3	0
	% change	+650		0	+900	-59	-40	-100
3	1986	7	1	3	3	70	15	1
	2001	25	1	4	25	40	5	0
	% change	+257	0	+33	+733	-43	-67	-100
6	1986	40	0	0	0	25	15	20
	2001	88	1	2	3	5	1	0
	% change	+120				-80	-93	-100
7	1986	45	0	1	5	40	5	4
	2001	79	0	1	10	10	0	0
	% change	+76		0	+100	-75	-100	-100
8	1986	50	0	0	0	10	15	25
	2001	85	0	2	2	5	1	5
	% change	+70				-50	-93	-80
9	1986	70	3	4	0	10	7	6
	2001	92	0	1	0	2	0	5
	% change	+31	-100	-75		-80	-100	-17
10	1986	35	3	3	0	40	12	7
	2001	85	1	1	0	5	5	3
	% change	+143	-66	-67		-88	-58	-57
11	1986	70	0	5	0	10	10	5
	2001	89	0	2	0	5	2	2
	% change	+27		-60		-50	-80	-60
	overall mean							
	1986	36	1	2	2	41	10	8
	2001	66	1	3	9	16	3	2
	% change	**+216**	**-11**	**+54**	**+215**	**-64**	**-70**	**-68**

[1] data from Deines and McClellan (1987)

Figure 1 Geographical extent of auklet colony and location of camp, banding plot and productivity plots at Sirius Point, Kiska Island in 2001

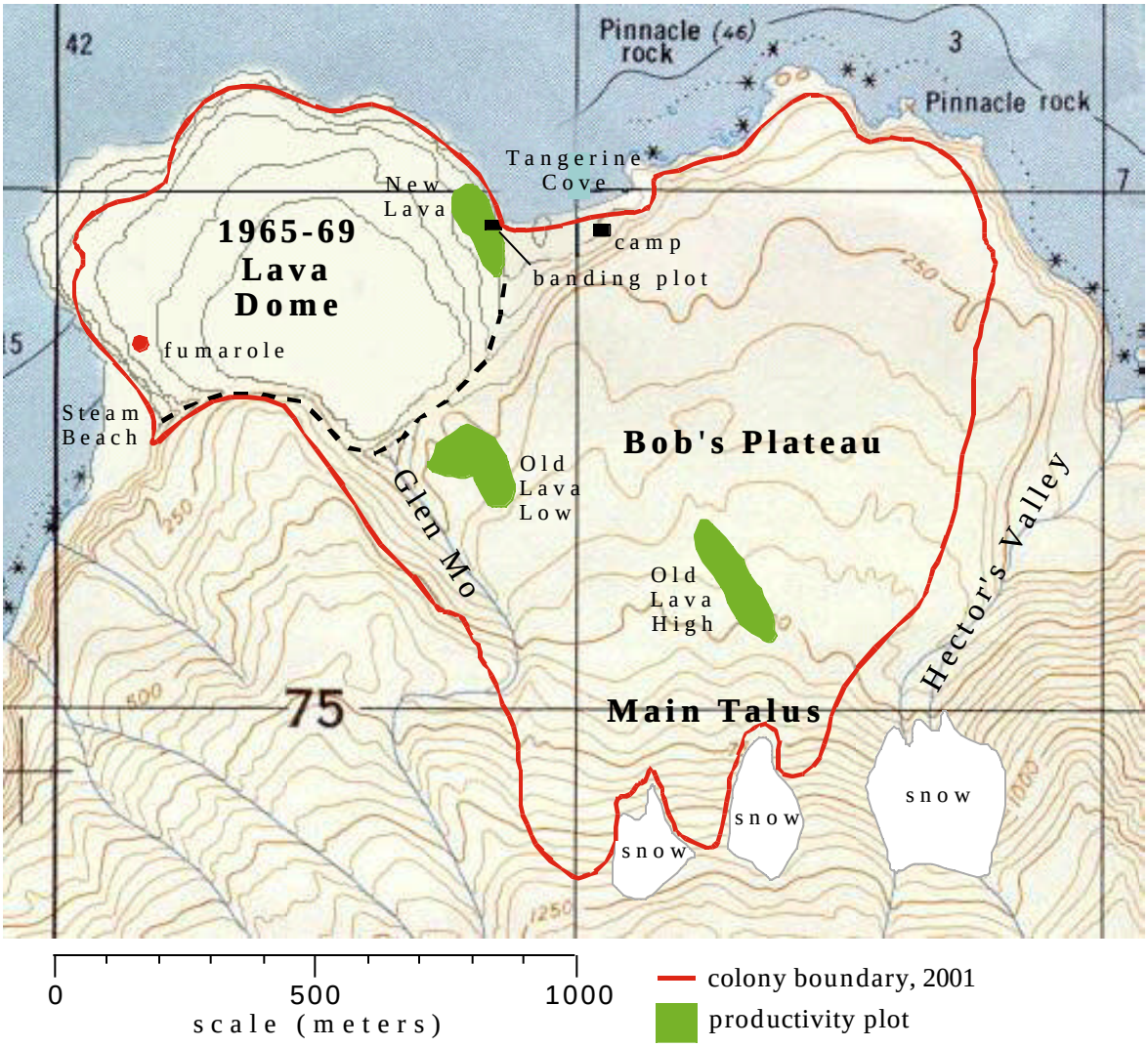


Figure 2 Survey station locations and estimated occupied crevice density at Sirius Point, Kiska Island in 2001

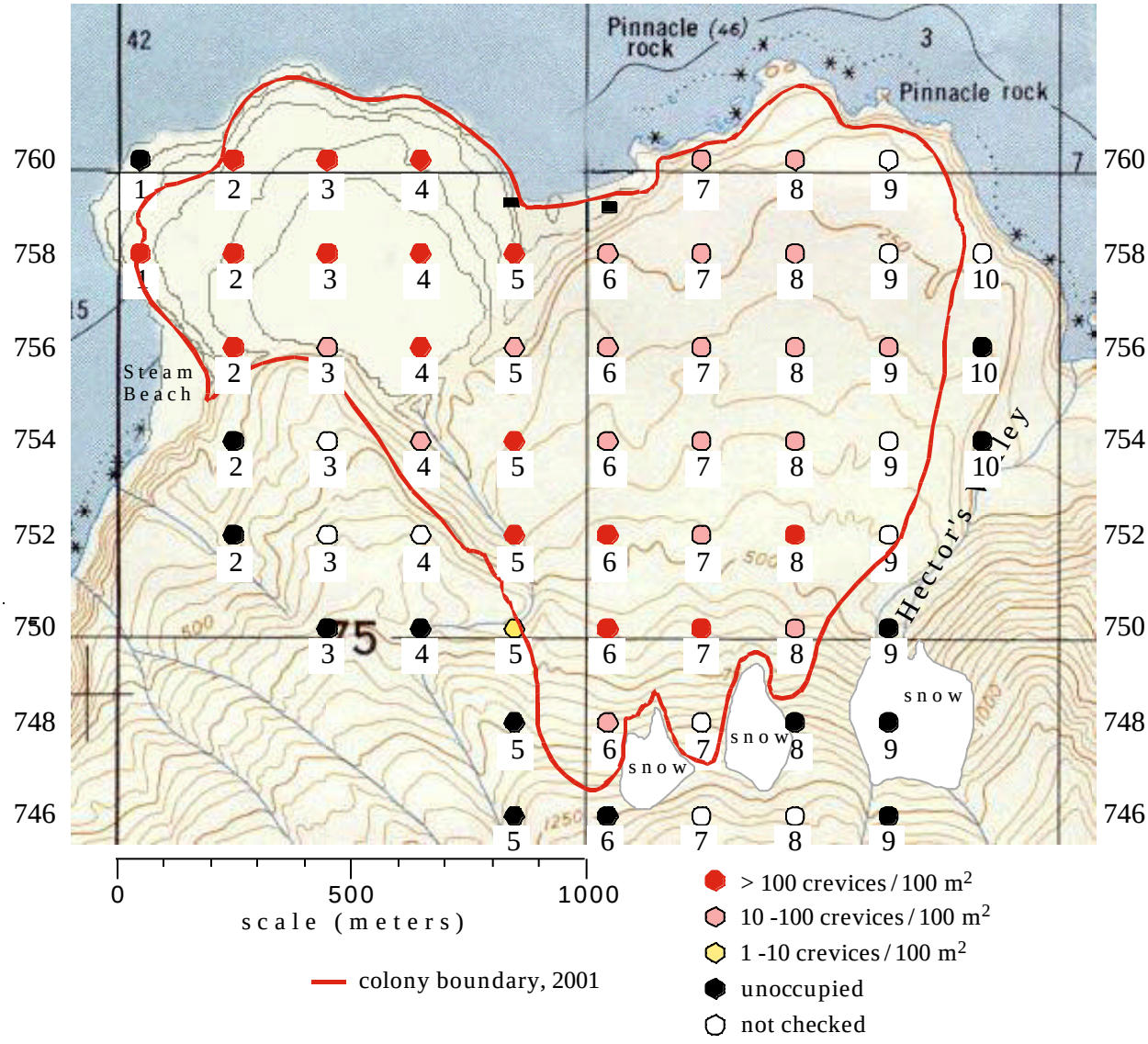
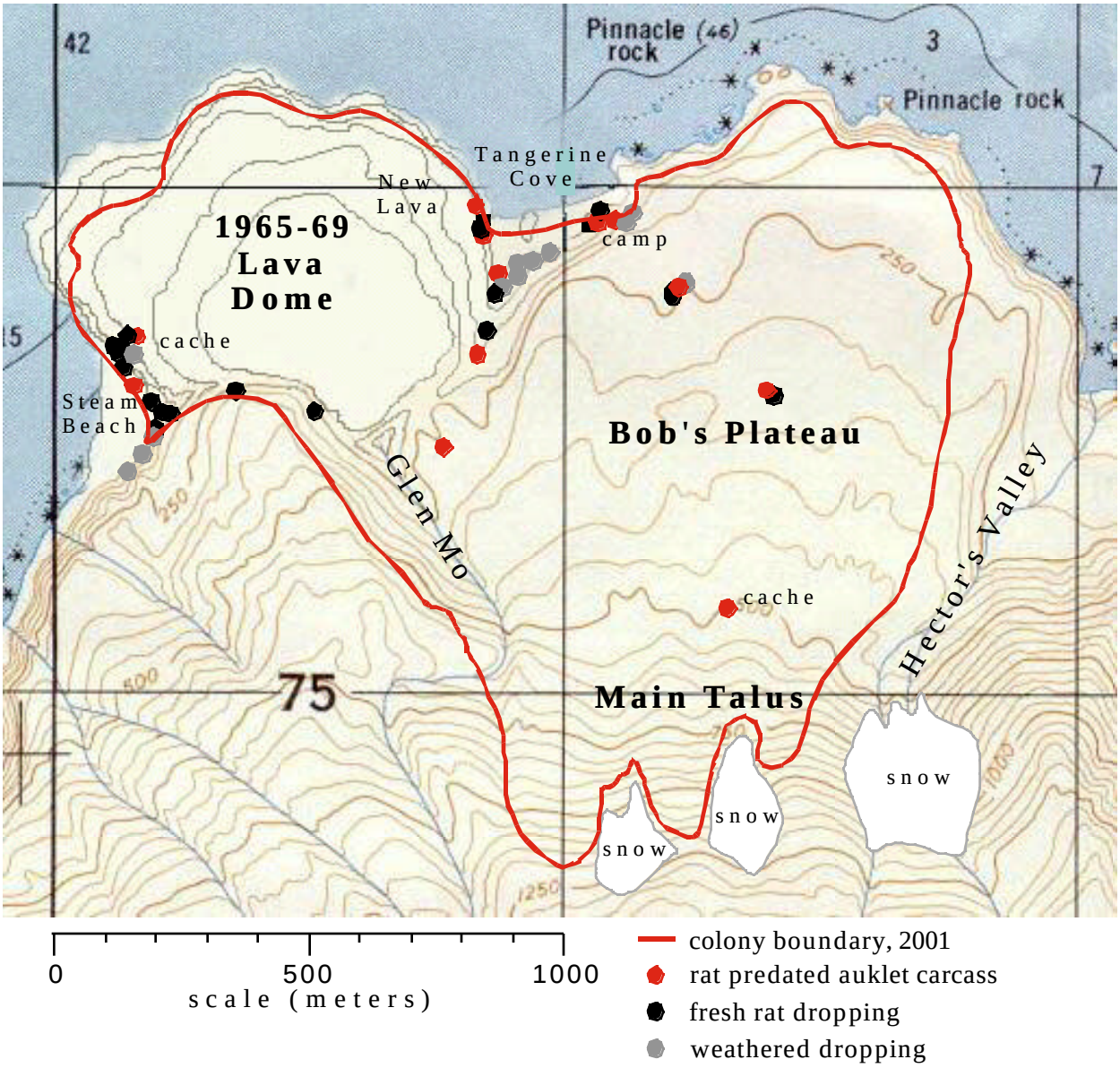


Figure 3 Locations where rat sign was found near Sirius Point, Kiska Island in 2001



Appendix 1 Summary of auklet predation by rats[1] detected at Sirius Point May 25-August 3, 2001

Date	Location	No.	Comments
May 24, 2001	Squid Cave	1	eyes chewed, neck bites
June 2, 2001	Old Lava High plot	38	cache, neck bites, eyes and brains eaten, four with heads missing
June 13, 2001	Steam Beach	1	eyes chewed, neck bites
June 15, 2001	banding plot, lava dome	1	eyes chewed, neck bites
June 26, 2001	camp	1	brain eaten, no other damage
July 13, 2001	near Steam Beach fumarole	4	rotted, together in cache
July 14, 2001	New Lava productivity plot	1	neck chewed, outside crevice 'L8?'
July 14, 2001	banding plot, lava dome	1	embryo half eaten, with eggshell
July 18, 2001	valley SW of camp	1	brain eaten out of back of skull
July 23, 2001	near camp	1	brain eaten, decomposed
July 27, 2001	old lava low plot	1	big chick, brain eaten
July 27, 2001	station 756-08	1	small chick, brain eaten
July 27, 2001	station 758-07	1	decomposed, brain eaten
July 29, 2001	valley SW of camp	1	fledgling chick, brain eaten
July 29, 2001	valley SW of camp	1	embryo half eaten, with eggshell

[1] All auklets predated were adults unless noted otherwise

Appendix 2 Birds seen during Sirius Point Study, May 25-July 31, 2001 (breeding species in bold face)

Common Loon *Gavia immer* Two heard at Christine Lake July 17.
Red-throated Loon *Gavia stellata* Heard and seen at Christine Lake July 16-17.
Short-tailed Albatross *Diomedea albatrus* One subadult flying by Sirius Point June 19.
Black-footed Albatross *Diomedea nigripes* Uncommon off Sirius Point.
Laysan Albatross *Diomedea immutabilis* Common, max count 56 in 15 minutes June 27 off Sirius Point.
Northern Fulmar *Fulmarus glacialis* Common, max 707 in 15 minutes June 21 off Sirius Point.
Short-tailed Shearwater *Puffinus tenuirostris* Uncommon, max 261 in 15 min June 23 off Sirius Point.
Mottled Petrel *Pterodroma inexpectata* Two seen flying by Sirius Point; June 24 and July 18.
Leach's Storm-Petrel *Oceanodroma leucorhoa* Rare off Sirius Point. Heard at night at camp.
Fork-tailed Storm Petrel *Oceanodroma furcata* Rare off Sirius Point. Heard at night at camp.
Pelagic Cormorant *Phalacrocorax pelagicus* Common, breeds locally.
Red-faced Cormorant *Phalacrocorax urile* Common, breeds locally.
Canada Goose *Branta canadensis* Flocks flying by Sirius Point regularly.
Mallard Anas platyrhynchos Two males at Christine Lake July 16.
Green-winged Teal Anas crecca Common at Christine Lake.
Northern Pintail *Anas acuta* Two males at Christine Lake July 15.
Greater Scaup *Aythia marila* Forty at Christine Lake July 16, one nest and two broods of ducklings.
Common Eider *Somateria mollissima* Lone males seen a couple of time flying by Sirius Point.
Harlequin Duck *Histronicus histronicus* Uncommon along beach, Christine Lake.
Pomarine Jaeger *Stercorarius pomarinus* Rare at sea off Sirius Point.
Parasitic Jaeger *Stercorarius parasiticus* Uncommon off Sirius Point, probably breeds at Christine Lake.
Glaucous-winged Gull *Larus glaucescens* Uncommon at auklet colony, breeds on island in Christine Lake.
Black-legged Kittiwake *Rissa tridactyla* Common, breeds locally.
Red-legged Kittiwake *Rissa brevirostris* Uncommon off Sirius Point, max count 51 in 15 min July 10.
Thick-billed Murre *Uria lomvia* Uncommon off Sirius Point, breeds locally (Pillar Rock).
Common Murre *Uria aalge* One seen July 12.
Pigeon Guillemot *Cepphus columba* Rare off Sirius Point (breeds locally?)
Parakeet Auklet *Cyclorhynchus psittacula* Uncommon breeder, Sirius Point.
Crested Auklet *Aethia cristatella* Abundant breeder, Sirius Point.
Least Auklet *Aethia pusilla* Abundant breeder, Sirius Point.
Whiskered Auklet *Aethia pygmaea* Rare breeder, Sirius Point, heard at night near camp.
Horned Puffin *Fratercula corniculata* Uncommon off Sirius Point.
Tufted Puffin *Fratercula cirrhata* Uncommon off Sirius Point.
Bald Eagle *Haliaeetus leucocephalus* Common breeder.
Peregrine Falcon *Falco peregrinus* Common breeder.
Rock Ptarmigan *Lagopus mutus* Uncommon on slopes of volcano; female & chick Christine Lake July 15.
Northern Raven *Corvus corax* Two birds July 18 only, one July 29, at auklet colony.
Winter Wren *Troglodytes troglodytes* Uncommon at Sirius Point, rare along shore of Christine Lake.
Yellow Wagtail *Motacilla flava* One at camp June 17.
Lapland Longspur *Calcarius lapponicus* Common in meadows.
Snow Bunting *Plectrophenax nivalis* Common in stony habitat.
Rustic Bunting *Emberiza rustica* One female was at Glen Mo June 13-18 and July 26.
(Song Sparrow *Melanospiza melodia* on Little Kiska Island only, absent from Kiska Island)
Gray-crowned Rosy Finch *Leucosticte arctoa* Uncommon at auklet colony.
Brambling *Fringilla montifringilla* Flock of 20 near camp May 24.