SHORT-TERM EFFECTS OF THE 2008 KASATOCHI VOLCANO ERUPTION ON CRESTED AND LEAST AUKLETS

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INTRODUCTION

Kasatochi Volcano, an island volcano located in the central-Aleutian chain, erupted on August 7th 2008, sending clouds of ash to 45,000-50,000 ft into the air and burying the island in ash and pyroclastic debris. The rarity of an eruption of this magnitude on a isolated small island created a unique opportunity to investigate the effects of a catastrophic natural disturbance on the terrestrial and marine habitats of marine birds. U.S. Geological Survey, in partnership with the Alaska Maritime National Wildlife Refuge, began an integrated study to study the eruption and its biological impacts in 2009. We visited Kasatochi Island in June and July of 2009 and June of 2010 to document marine bird occurrence on the island, and survey the local marine environment. Our findings were compared with previous surveys of the area to determine short term effects on Crested and Least Auklets, the most abundant nesting species on the island prior to the eruption.

STUDY AREA

Kasatochi Volcano, a small, 3 km diameter, 300 m high, island volcano in the central Aleutian Islands of Alaska (52.17° N, 175.51° W, Fig. 1) erupted violently on August 7, 2008. The resulting ash and pyroclastic flows blanketed the island, covering terrestrial habitats in 15-20 meters of material and increasing the size of the island substantially (Fig. 2).

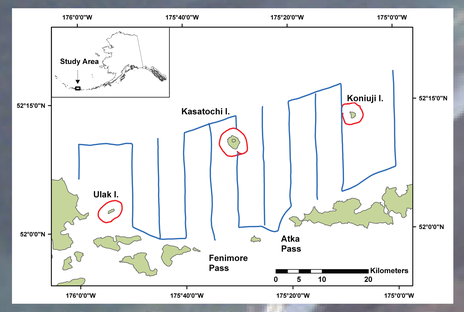

Figure 1. Location of Kasatochi, Ulak and Koniuji Islands, Alaska. The volcano lies approximately 1900 km west of Anchorage in the western Aleutians. Red lines represent the at-sea survey tracks for seabirds during July of 1996 and 2003, and June of 2009.

Figure 2. Landsat image of Kasatochi Island from April 12th, 2009. The yellow line represents the shoreline prior to the 7 August 2008 eruption.

METHODS

We examined the effect of the eruption on the marine environment through the use of SeaWifs satellite imagery and physical sampling in June and July of 2009. We created an anomaly layer by subtracting the five-year mean estimate of chlorophyll-*a* concentration form the 2008 estimate. Values greater than zero indicate higher than average chlorophyll-*a* concentrations and negative values indicate lower than average concentrations. We evaluated the short-term effects of the eruption on Crested and Least Auklets through a visit to the colony in June of 2009 and June of 2010. We examined marine estimates of seabird abundance with at-sea surveys from the M/V *Tiglax* using standard protocols for strip transect sampling throughout the study area. To examine changes in auklet densities around the three islands in the study area, we compared a subset of the at-sea data. Circumnavigations of each island were conducted at approximately 1.8 km from the shore and were split into 10-minute segments. Species numbers were summed and divided by the area sampled to determine densities. The combination of the sample sizes and high variance precluded the use of parametric tests. Instead, we constructed 90% confidence intervals (CI) by bootstrapping segment densities for each island, year, and taxa, and identified non-overlapping CIs as significant (Davison and Hinkley 1997). If the eruption had an impact on Crested or Least Auklet populations or their return to the island, we would expect to detect significant changes in their average density around Kasatochi. We examined pre and post-eruption distributions by constructing anomaly surfaces, 2009 densities minus the mean densities from 1996 and 2003.

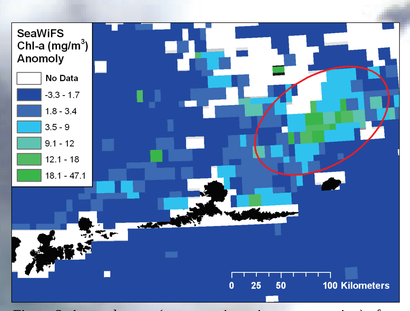

Figure 3. Anomaly map (post-eruption minus pre-eruption) of chlorophyll-*a* concentrations following the 7 – 8 August, 2008 eruption. Pre-eruption layer was the mean of September 2003-2007. The ellipse designates a contiguous area of anomalously high chlorophyll-*a*.

Figure 4. Pre- and Post eruption Images from the primary Crested and Least Auklet colony on the northwest coast of Kasatochi Island.

RESULTS

•The anomaly layer, based on pre- and post-eruption chlorophyll-*a* reflectance, indicated a 3,240 km² area approximately 200 km to the northeast of Kasatochi with elevated chlorophyll-*a* concentrations (Fig. 3). The location of this anomaly closely approximated what was predicted based on current direction and speed. Water samples from June and July of 2009 failed to detect any longer term nutrient contributions.

•Crested and Least Auklets returned in large numbers to their former colony site (Fig. 4). Despite a lack of any nesting sites, birds were noted copulating and eggs were dropped though not attended on the slope (Fig. 5 and 6).

•Anomaly plots of Crested and Least Auklet Distributions showed little difference between pre- and post-eruption distributions (Fig. 7).

•At-sea surveys at all three islands failed to detect any difference in pre and post eruption at-sea densities of both birds in the control group (Uncommon/Non-nesters) and of Crested or Least Auklets around Kasatochi (Fig. 8).

DISSCUSSION

Comparing the September 2009 SeaWiFS image with a mean of September pre-eruption images (2003–2007), we were able to identify an area of anomalously high chlorophyll-*a* concentration to the northeast, directly downstream from the Aleutian North Slope Current. Given the easterly flow of the Aleutian North Slope Currents surface waters, this anomaly is consistent with a fertilization event in the time period of the eruption. This finding corroborates the results of Langmann et al. (2010) who also identified fertilization from this eruption using MODAS satellite imagery at a much broader scale. However, we found no evidence of elevated nutrients around Kasatochi Island in June 2009 despite the considerable erosion of volcanic sediments into the sea, and do not expect the eruption will affect marine productivity of the area.

We found post-eruption densities of all taxa tested were similar to pre-eruption surveys, suggesting that most adult birds survived the eruption. The return of Crested and Least Auklets to Kasatochi Island in 2009 was not unexpected given the strong nest site fidelity generally exhibited by these two species (Sealy, 1975; Roby and Brink, 1986; Piatt et al., 1990; Jones, 1993). Despite the extreme change in habitat at the primary colony site, both Crested and Least Auklets exhibited typical behaviors, e.g. courtship and copulation. Given that nest-sites are unavailable and may remain so for the lifespan of the Crested and Least Auklets that were present in 2008, these birds are faced with three possible scenarios: (1) Continue returning to Kasatochi; with no nest sites available populations will decline steadily towards extirpation, (2) Continue returning to Kasatochi until nesting habitat is exposed through erosion, and then, based on the amount of nesting habitat, populations should stabilize at a lower level and perhaps eventually increase, or (3) Abandon the colony and seek out new nesting habitat at other islands, resulting in a swift decline over the next few years and an increase in densities around alternative sites, e.g. Koniuji Island.

ONGOING RESEARCH

Our research at Kasatochi is ongoing. The effect of this eruption on the avifauna of the area will not be clear for several years. In June 2010 we installed a pair of time-lapse cameras at the primary colony site. Images from these cameras will be used to examine erosion rates and Auklet attendance. One camera is focused on the colony slope to provide information on diel attendance, time of Auklet departure, and arrival at the colony. The second camera is focused on the bluff below the colony. This bluff, made up of ash and pyroclastic debris, has been suggested as the primary limiting factor in the erosion of ash from the colony site. This bluff's rate of change will play a major role in determining when nesting habitat will once again be available.

Reconnaissance in 2010 found that Crested and Least Auklets returned again but still lacked nesting habitat. We did note the first successful nest since the eruption. The nest, on the southeastern portion of the island, was that of a Peregrine Falcon (Fig. 9).

Figure 5. The old colony site buried under meters of ash. Numerous gullies can be seen running down the slope.

Figure 6. Egg-shell remnants in one of the many gullies on the old colony slope.

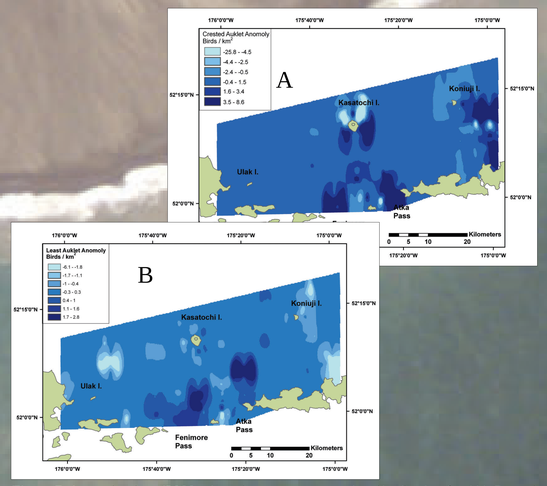

Figure 7. Anomaly plots (2009 minus the mean pre-eruption distribution for (A) Crested and (B) Least Auklets .

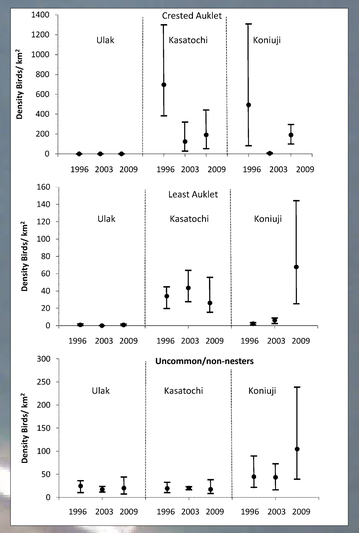

Figure 7. Densities from at-sea surveys around Kasatochi, Koniuji, and Ulak Islands. Densities were based on circumnavigations of each island.

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ACKNOWLEDGMENTS

We thank Tony DeGange for spearheading the USGS integrated investigation of the Kasatochi eruption. This work would not have been possible without the past and continuing support of the U.S. Fish and Wildlife Alaska Maritime National Wildlife Refuge. We especially thank Vernon Byrd, Jeff Williams, and the crew of the *M/V Tiglax* for their commitment to this work. We thank the North Pacific Research Board, U.S. Fish and Wildlife Service and U.S. Geological Survey for providing funding for the post-eruption research.

Figure 8. Time-lapse cameras at the northeastern colony site.

Figure 9. Peregrine Falcon chicks at the first successful nest documented since the 2008 eruption.