Variations in the diet of introduced Norway rats (*Rattus norvegicus*) inferred using stable isotope analysis

Keywords

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Abstract

The presence of introduced Norway rats has raised concerns for the fate of the large least auklet *A* colony situated at Sirius Point, Kiska Island, Alaska. Previous studies have documented extreme interannual variation in least auklet reproductive success and potential drastic population declines, both of which have been attributed to the varying abundance of, and predation by, Norway rats. A diet study would resolve the uncertainty that remains about the role of rats in the auklet's reproductive failure and the colony's decline. Our main objectives here were to quantify the variation in diet of introduced Norway rats and assess predation on least auklets. Using stable isotope analysis we document wide variability in rat diet dependent on location and provide direct evidence that Norway rats are preferentially preying on least auklets at Sirius Point. In conclusion, we hypothesize that the observed wide variability in rat diet will contribute to the persistence of rats on Kiska long after auklets have been extirpated. The persistence of rats enabled by their foraging plasticity will increase

readily available and highest nutritional quality prey may be, as suggested by Drever & Harestad (1998). In particular, we hypothesize that rats at Sirius Point will feed preferentially on least auklets.

Materials and methods

Study site

Our research was undertaken at Kiska Island (52°N, 177°E; Fig. 1), part of the Alaska Maritime National Wildlife Refuge (AMNWR). Kiska is the second largest island in the Rat Islands group in the western Aleutian Islands, Alaska, USA, is 39.8 km long and varies in width from 2.8 to 11 km, with a total area of 28 177 ha. Kiska Island is a remote treeless oceanic island, lying more than 800 km from the nearest continental land masses, with wet meadows of grasses (, spp., spp.), umbellifers (, *A*) and various fern species in low-lying areas, alpine heaths in higher inland areas, and sparse to no vegetation at higher elevations and on recent lava flows and domes. At Sirius Point (52°08′N, 177°37′E) a large least and crested *A* - auklet colony is situated on two lava domes located at the base of the north slope of Kiska Volcano. The auklet colony occupies a surface area of . 1.8 km^2 and hosted more than 1 million breeding least auklets in 2001 (I. L. Jones, unpubl. data).

Norway rat collection

We collected 40 Norway rats using snap traps at both Sirius Point (auklet colony, = 20, 52°08.013′, 177°35.854′; Fig. 1) and Christine Lake (brackish lagoon with access to nearby intertidal zone, = 20, 52°05.004′, 177°33.072′; Fig. 1) in each of 2002 and 2003. Collections began over a month after the arrival of auklets at Sirius Point and continued until our departure from Kiska in early August, ensuring an auklet signature would be present in both pectoral muscle (turnover time of 1 month) and liver tissue (turnover time of 1 week) of Norway rats if they were being consumed. At Sirius Point we used unbaited traps placed along visibly used rat trails in grassy areas because rats were not attracted to bait. At Christine Lake rats were trapped with nearly 100% (per night) trapping success using traps baited with the fresh flesh of Dolly Varden from the lake. Using traps baited with the Dolly Varden, canned mussels and peanut butter, we trapped a total of 12 rats at East Kiska Lake (2.5 km inland, at 52°04.459′, 177°35.011′; Fig. 1) in 2003 and 2004. Liver and pectoral muscle tissue samples were taken from each rat killed. In addition, we opportunistically sampled potential rat prey items at both Sirius Point and Christine Lake, including amphipods, Dolly Varden, freshwater algae, and liver and pectoral muscle from 20 adult least auklets and 10 adult crested auklets found freshly dead on the auklet colony. All samples were analysed in order to assess rat diet across Kiska Island.

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We dried all isotope samples in an oven immediately after sampling for 3 h at 60 °C and then stored them in o-ring vials while in the field. Once in the lab we crushed and removed lipids from all isotope samples using a 2 chloroform:1 methanol rinse as modified from the Bligh & Dyer (1959) method. By removing lipids we were able to compare ingested protein (i.e. nutrients) but not fats. Once lipids SIASIASIASIASIA

deviation of sample repeats within a run was never greater than 0.34‰ for $\delta^{13}C$ and 0.64‰ for δ

Furthermore, as seabird populations are -selected, adult survival being crucial in maintaining the population, they are particularly vulnerable to adversity (Croxall & Rothery, 1991). As rats appear to feed on adults as well as chicks and eggs at Kiska (Major & Jones, 2005), a least auklet population crash may be inevitable. In general because rats can survive without seabirds as a source of food, if a seabird population crashes, rat numbers will likely continue to be high, making seabird recolonization impossible, as any recolonizing individuals would experience intense predation pressure. In light of this we recommend that all mitigation plans address not only eradicating/controlling rats at seabird colony sites but also keeping potential invaders from returning. It is clear from our results that understanding the ecology of these non-seabird colony rats is vitally important for the conservation of insular avifauna and the ecological restoration of islands.

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