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Received 5 April 1979, accepted 10 May 1979.

Tufted Puffins Nesting in Estuarine Habitat

ROBERT GILL, JR. AND GERALD A. SANGER
U.S. Fish and Wildlife Service, 1011 E. Tudor Road, Anchorage, Alaska 99503 USA

The Tufted Puffin (*Lunda cirrhata*) apparently has the most extensive breeding distribution of any North Pacific seabird, extending in the western North Pacific from Hokkaido to the north Chukotsk Peninsula on the Chukchi Sea, and in North America from Cape Lisburne on the Chukchi Sea, south to the Farallon Islands off central California (Udvardy 1963). Despite this wide breeding distribution, the reported nesting habitat is generally restricted to steep, rocky islands and continental headlands (see Dement'ev and Gladkov 1951, Kozlova 1957, Gabrielson and Lincoln 1959, Portenko 1973, Sealy 1973, and Sowls et al. 1978). Nests are typically excavated in steep slopes and/or on vegetated plateaus, well above normal tidal influence but occasionally within the spray or storm-wash zone. Nowhere has *L. cirrhata* or any other puffin species been reported to nest in a flat, estuarine habitat in substrate normally affected by tides during the breeding season. Portenko (1973: 137) refers to Tufted Puffins breeding on Alyumka Island in the Anadyr "estuary" (64°40′N, 177°37′E), but Alyumka Island is a rocky coastal island having immediate offshore waters between 3–18 m deep (A.A. Kistchinski, The Ringing Center, Moscow, and George Tyner, U.S. Defense Mapping Agency, pers. comm.).

During the summers of 1976, 1977, and 1978, we found 14–18 pairs of Tufted Puffins nesting on 4 narrow sand islands (5–7 ha each) along the northcentral Alaska Peninsula at Nelson Lagoon (56°00′N, 161°10′W). As of June 1979, 25 active burrows had been reported there (Margaret R. Petersen, pers. comm.). The islands lie approximately 1.3 km from the Bering Sea coast and are protected from the sea by a long, narrow (0.5 km) sand peninsula. The main deepwater channel in the lagoon, 3–7 m deep and 100–300 m wide at mean low water (MLW), separates the islands from the peninsula. The islands, which are free of permafrost, have a uniformly low profile with the highest elevation 1–2 m above mean high water (MHW) (Fig. 1). Each island is circumscribed by a gently sloping (<5°), narrow (5–15 m) sand/gravel beach that graduates at MLW to intertidal mud- and sandflats. These are extensive on the south and southeast sides (several hundred m) and relatively narrow (10–20 m) on the north and northwest or channel sides. The banks of each island are moderate to near vertical in slope. Puffin burrows face the channel, are located at or near the vegetation/beach interface, and extend into the bank horizontally or slightly downward. Beach rye (*Elymus arenarius mollis*) grows over most of each island and is used as nesting cover by several hundred Glaucous-winged Gulls (*Larus glaucescens*) and lesser numbers of Common Eiders (*Somateria mollissima v-nigra*). Predation by gulls on puffin eggs or chicks was not observed, nor did we see gulls rob food from adult puffins returning to their burrows from foraging in the Bering Sea (cf. Nettleship 1972). Puffins were never observed feeding in the lagoon.

Fig. 1. Tufted Puffin nesting habitat at Nelson Lagoon during a moderately high tide showing island elevation, beach slope, and the beach/bank interface where burrows are located. The person's height is 1.56 m.

Definitions of tidal datum appear in USDC (1975). Tides at Nelson Lagoon are semidiurnal with an average annual diurnal range of 5.4 m. We determined mean higher-high water (MHHW) for Nelson Lagoon at approximately +3.3 m above 0.0 datum. The highest predicted tides between April and September each year at Nelson Lagoon occur at approximately 4.1 m above 0.0 datum. Due to the combined effects of wind, atmospheric pressure, and the shallow (<20 fm) adjacent Bering Sea shelf, however, actual tides can vary considerably. During 1977, the mean elevation of entrances of 18 active burrows was 88 cm (SD = 31, range = 31–160) above MHHW, or slightly above the level of the highest tides unaffected by wind, rain, or atmospheric pressure predicted between May and October.

Nine of 18 burrows had entrances lower than the highest tides predicted for the nesting period (late May–early September). Of these, the lowest was potentially subject to flooding by approximately 30% of all predicted high tides each lunar cycle during the nesting period, while the other 8 were susceptible to flooding by less than 5% of the predicted high tides each lunar cycle. Between May and July, however, none was flooded, probably due to the effects of wind and/or atmospheric pressure suppressing tide level. A 30 millibar change in pressure is known to cause a 0.305-m change in sea level (Wise and Searby 1977). Generally, such opposing conditions to tides exist in the southeast Bering Sea during early summer each year (Brower et al. 1977).

Beginning in mid-August, however, the storm track in the southeast Bering Sea and west Gulf of Alaska shifts (Brower et al. 1977), increasing the frequency and intensity of storms and subsequently increasing the potential for burrows to be flooded by storm tides. Indeed, on 26 August 1977, a storm tide flooded three active burrows and killed at least one chick. We did not learn the fate of the other two chicks, but their 25 August weights of 300 and 450 g suggests that they were too small to fledge (see beyond). Between 15 and 19 September 1977, another even higher series of storm tides completely washed away two burrows, but we suspect that these chicks fledged, as their 4 September weights of 520 and 570 g were approaching the known fledging weight (D.H.S. Wehle, USFWS, unpubl. data). In late August 1976 and early September 1978, storm tides flooded several burrows and, in late September 1978, washed on top of several islands, indicating that such flooding occurs regularly in late summer. In none of these instances was the predicted tide alone sufficient to flood any of the burrows.

Why, then, do Tufted Puffins nest at Nelson Lagoon? We have no clear evidence, but speculate that their initial colonization might possibly have resulted from inter- and intraspecific competition for nest sites at the few typical seabird rookeries in the southeast Bering Sea, or possibly the west Gulf of Alaska

(Sowls et al. 1978), leading to a pioneering effort at Nelson Lagoon. At least three other lagoon/barrier island systems occur along the north Alaska Peninsula, but Nelson Lagoon affords the only such area that is normally free of mammalian predators, at least during the nesting season (Robert Jones, Jr. pers. comm., and RG pers. observ.). This attribute alone could have allowed initial colonization and may continue to encourage nesting despite some apparent annual loss of chicks from storm tides.

We do not know the consequence of such loss to the continued existence of this small population. The colony has apparently existed for several years, however, whether self-sustaining or by recruitment from other colonies. Local residents and transient fishermen had seen "sea parrots" in the lagoon channel during the nesting season for several years prior to 1976, although none was aware of nesting prior to this. We thus believe that these sightings were probably of local nesting birds, as we saw puffins in the lagoon only in the immediate vicinity of burrows. The nearest known colonies are 120 km WSW and 340 km N of the lagoon, but Tufted Puffins are suspected of nesting in Moller Bay, 48 km ESE of the lagoon (RG pers. observ.).

A further observation from this study is that of the relative ease with which adult puffins can take off from and land on essentially flat, unvegetated ground. We frequently watched adults walk from their burrows and, without aid of wind and often while running perpendicular to the slight slope of the beach, become airborne within 3–4 m. At least one investigator (Kozlova 1957: 112) has stated that *L. cirrhata* is "unable to rise from level ground." More recently, Kees Vermeer (pers. comm.) has suggested that, because of high wing loading, Tufted Puffins nesting in typical situations facilitate landing and taking off by selecting burrows on steep slopes. Nevertheless, our observations indicate that they are fully able to take off from and land on level ground.

This investigation was part of the Outer Continental Shelf Environmental Assessment Program (OCSEAP) funded by the Bureau of Land Management through the National Oceanic and Atmospheric Administration (NOAA). We thank Margaret Petersen, Colleen Handel, Paul Jorgensen, Anthony DeGange, and Jay Nelson for their field assistance. Spencer Sealy, David Nettleship, Patick Gould, and Colleen Handel provided helpful suggestions on improving the manuscript. We especially thank the people of Nelson Lagoon for their cooperation and hospitality.

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Received 20 February 1979, accepted 5 July 1979.