

Significance of unique terrestrial and marine habitats in Tuxedni Bay, Alaska, for shorebirds and seabirds

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Seabirds breed on Duck Island, and Chisik Island in the background, both of which are part of the Alaska Maritime National Wildlife Refuge. Photo: Hamish Laird

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Introduction:

Tuxedni Channel is located on the western side of Cook Inlet, Alaska. This narrow band of water separates the mainland coast (part of Lake Clark National Park) on the west from Chisik Island to the east (see Figure 1). The Lake Clark coastline of Tuxedni Channel is characterized by rich mud flats, anadromous streams, and large sedge meadows known for their concentration of grazing brown bears. In contrast, the coast of Chisik Island is dominated by towering cliffs, rocky beaches, and seabird colonies teeming with life. There is a small island (Duck Island) off the eastern coast of Chisik Island, and together, these two islands comprise the Tuxedni Wilderness area. The Tuxedni Bay area is rich with bird-life, and provides important habitat for breeding, migrating, and wintering birds, including raptors and waterfowl. This report summarizes the importance of the Tuxedni area for two bird groups that use these shorelines: shorebirds and seabirds.

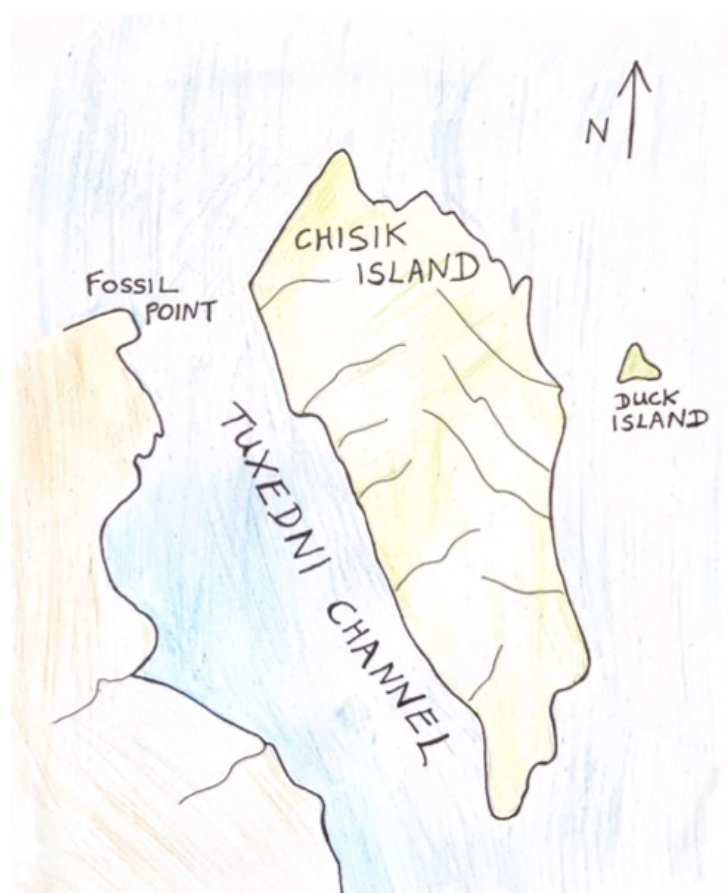


Figure 1. Location of Tuxedni Channel, Chisik Island and Duck Island on the West Coast of Cook Inlet, Alaska.

Shorebirds:

Many shorebird populations are declining around the world (Rosenberg *et al.* 2019; Smith *et al.* 2023), and one of the main causes is loss of habitat (Koleček *et al.* 2021; Wang *et al.* 2022).

Cook Inlet provides important habitat for migratory shorebirds which feed primarily on a small, but energy-rich, bivalve (*Limecola balthica*) that occur in high densities along the tidal mud flats that flank the western shores (Gill and Tibbitts 1999; Ruthrauff *et al.* 2013).

Cook Inlet supports a high percentage of the Pacific Flyway population of Western Sandpipers (*Calidris mauri*) during the spring migration (Gill and Tibbitts 1999). Along this route, key places, like Tuxedni (Gill and Tibbitts 1999), offer places for resting and refueling. The loss of even one migratory stop-over can affect the whole system (Wang *et al.* 2022).

Cook Inlet is also the most northerly non-breeding site for wintering shorebirds in the Pacific Basin (Ruthrauff *et al.* 2013), and is an especially important non-breeding resource for the largest bodied subspecies of Rock Sandpipers (*Calidris ptilocnemis ptilocnemis*). This Rock Sandpiper is a subspecies of high conservation concern that breeds exclusively on remote islands in the Bering Sea, and then spends the winter in Cook inlet (Gill and Tibbitts 1999; Ruthrauff *et al.* 2013; see Figure 2). The high density of *Limecola* clams and the large tidal and current influences allow these birds to successfully survive the extremely cold and icy conditions of winter in Cook Inlet (Ruthrauff *et al.* 2013). Surveys have shown that this subspecies of Rock-Sandpiper usually winters in Upper Cook Inlet, primarily in Susitna Flats and Trading Bay, but that Tuxedni provides important winter habitat during extremely cold winters when birds move south in Cook Inlet (Ruthrauff *et al.* 2013). During these times of displacement, the total percentage of Rock Sandpipers in Cook Inlet rose from 0% to over 60% in Tuxedni Bay (Ruthrauff *et al.* 2013).

The Western Hemisphere Shorebird Reserve Network (WNSRN) has established a range of categories to identify and help conserve the most important shorebird areas, and Tuxedni qualifies as an Hemispheric site of importance (supports at least 500,000 shorebirds annually, or 30% of a species flyway population) for Rock Sandpipers, and as an important

International site (supports at least 100,000 shorebirds annually, or 10% of a species flyway population) for both Western Sandpipers and all shorebirds (Gill and Tibbitts 1999).



Figure two: Rock Sandpipers roosting along the icy shore of Cook Inlet. Photo credit: Dan Ruthrauff, US Geological Survey.

Seabirds:

Global populations of the world's monitored seabirds have declined by 69.7% from 1950-2010 (Peleczny *et al.* 2015), and this group of birds face many threats, including climate change, invasive species, and disturbance (Dias *et al.* 2019).

Seabird densities in lower Cook Inlet are among the highest in Alaska (Sowls *et al.* 1978), and the large resident and migratory seabird populations are supported by key forage fish species such as capelin, sand lance, juvenile walleye pollock, and herring (Abookire and Piatt 2005; Piatt *et al.* 2007).

Seabirds breed on Chisik and Duck Island (see figure 3), and these populations are both locally important for their sheer numbers and also for the long-term studies that are providing

crucial understanding about the response of seabirds to oceanographic change (Piatt *et al.* 2007; Marsteller *et al.*, 2024; Schoen *et al.* 2024). Together with Gull Island (in Kachemak Bay) these colonies have the most comprehensive concurrent long-term study on the local availability of forage fish and seabird demographics and behavior in Alaska.

Chisik Island is 2606 ha in area, has a peak elevation of 815 m, and is located about 0.8 km from the mainland. Duck Island is 0.4km east of Chisik, covers about 2.4 hectares, and has a maximum elevation of 49m (see Figure 3). President Roosevelt established the Tuxedni National Wildlife Refuge (encompassing most of Chisik Island and its smaller neighboring island of Duck) on February 27, 1909, primarily to protect the large colonies of breeding seabirds (USFWS, 1966).

The refuge was federally designated as wilderness in 1970, and the two islands were included in a subunit of the Alaska Maritime National Wildlife Refuge (AMNWR) in 1980. Biologists censused seabird populations here in the early 1970s (Snarks 1970, 1971 a-b, 1974) and AMNWR personnel monitored seabird populations intermittently through the 1980s and 1990s (Jones *et al.* 1980; Kafka 1984; Beringer and Nishimoto 1988; Slater *et al.* 1994).

Intensive study of both local prey availability and the response of seabirds breeding on Chisik Island and Duck Island began in 1995 and continued until 1999 (Piatt 2002). Following the North Pacific marine heatwave of 2014-2016 (Emanuele *et al.* 2016), these surveys were repeated in order to quantify and help understand the impact of the heatwave on seabird populations (2016 until current; see Arimitsu *et al.* 2021; Schoen *et al.* 2024; Marsteller *et al.* 2024).

Two species of alcid breed on Chisik Island and Duck Island (the Common murre: *Uria aalge* and the Horned puffin (*Fratercula corniculata*). The Tufted Puffin (*Fratercula cirrhata*) and the Parakeet Auklet (*Aethia psittacula*) breed on Duck Island. And a fifth species of alcid, the Pigeon guillemot (*Cepphus columba*) breeds in rocky crevices at Fossil Point (see Figure 1; Zador *et al.* 1997). Glaucous-Winged Gulls (*Larus glaucescens*) and Black-Legged Kittiwakes (*Rissa tridactyla*) breed along the cliffs of Chisik Island, and Double Crested Cormorants (*Nannopterum auritum*) nest at spectacularly high elevation on the north east coast of Chisik Island. In this report, we focus on the populations of the three most numerous and well-studied species of seabirds breeding within the Refuge: The Black-Legged Kittiwake, Common Murre, and Horned puffin.



Figure 3: Overview photo of Duck Island. Photo: Hamish Laird

Black legged kittiwake

Black-legged kittiwakes are a small colonial gull species that breed on steep cliffs in the Northern Hemisphere. The largest of the kittiwake colony in the Tuxedni Wilderness Area is on the southern edge of Chisik, just south of the Snug Harbor Cannery. Kittiwakes have also nested on the cliffs along the outer (East) coast of Chisik Island and on Duck Island (Zador *et al.* 1997). There has been a continual decrease in the population size of kittiwakes breeding on Chisk Island and Duck Island since the 1970s (Zador *et al.* 1997, Piatt *et al.* 2002, Arimitsu *et al.* 2021), and the average population census between 2016-2019 was only 4397 individuals (Arimitsu *et al.* 2021). This is a sharp decline from an estimated 20,000 individuals counted in 1970 (historical population counts summarized in Zador *et al.* 1997). This population decline has led to a contraction of their local range, and there has been no kittiwakes breeding on Duck Island in recent years. Low breeding success or complete

breeding failure of black-legged kittiwakes at the Chisik and Duck colonies has also been frequently reported (see summaries in Zador *et al.* 1997; Piatt *et al.* 2002; Arimitsu *et al.* 2021).

Common murre

The common murre is one of the most numerous seabirds in the Northern Hemisphere, and it has circumpolar distribution (Ainley *et al.* 2002). Historically, murres have nested all along the outer (eastern) coast of Chisik Island and on the cliffs of Duck Island (Zador *et al.* 1997). Similar to the Black-legged Kittiwakes, the population of murres on Chisik Island and Duck Island has dramatically decreased from estimates of 20,000-25,000 in the 1970s (summarized in Zador *et al.* 1997) to an average of 798 individuals counted between 2016-2019 (Arimitsu *et al.* 2021). Murres usually breed in large colonies on narrow cliff ledges and rocky islands (Gaston and Jones 1998), and their colonial behavior is an important adaptation for predator defense. Increased predation has been observed at declining colonies of murres and this can result in breeding failure (Marsteller *et al.* 2024). As the population at Chisik and Duck has decreased, murres are preferring to nest in alternative habitats that provide a natural protection from Glaucous-Winged Gulls and Bald Eagles (*Haliaeetus leucocephalus*). Whereas cliff-nesting murres on Chisik and Duck sometimes experience low breeding success or total failure (Arimitsu *et al.* 2021), the murres nesting under the dense alder and elderberry bushes on Duck Island have been successful.



Figure 4. Common Murres nesting under the protective canopy of elderberry bushes on Duck Island. Photo: Ann Harding

Horned Puffin

Alaska holds over 80% of the world population of Horned Puffins, with the majority (62%) breeding off the Alaska Peninsula (Gaston and Jones 1998). The Horned Puffin almost always nests among boulders and in rock crevices, making access to nest-sites and chicks difficult and complicating the study of their breeding biology. Subsequently, very few studies have focused on the Horned Puffin (eg. Amaral 1977, Wehle 1980, Wehle 1983), and it remains one of the least studied seabirds in Alaska. Duck Island has a relatively large data-set on Horned Puffins, with intensive study on their diet, chick growth, colony attendance and behavior conducted between 1995-1999 (Piatt 2002; Harding *et al.* 2002; Harding *et al.* 2003), and more recently between 2019 to current. It is difficult to survey crevice-nesting seabirds because nest-sites are hard to identify and count, and the number of adult birds attending a colony is extremely variable within and between days (Harding *et al.* 2005). Horned Puffins breed in the rock crevices surrounding the coast of Duck Island, and the highest whole-island population counts during the 1995-1999 study ranged from a low of 959 individuals in 1996 to 4370 individuals in 1999 (Piatt 2022), and in recent years annual high

population counts were 1978 individuals in 2023 and 2075 individuals in 2024 (Harding unpublished data).

The importance of Chisik and Duck Island seabirds as indicators of the marine environment

Study of the marine ecosystem can be very expensive, due, in part, to costs associated with the complex challenge of conducting research at sea. In contrast, seabirds are relatively easy and cheap to study on land during their breeding season, and have been shown to provide a sensitive indication of the health of marine ecosystems when aspects of their biology or behavior respond in a predictable manner to changes in food availability (e.g., Cairns 1987; Durant *et al.* 2003; Frederiksen *et al.* 2004; Piatt *et al.* 2007).

The seabirds breeding on Chisik Island and Duck Island have been the focus of intensive research for the last three decades, and the parallel collection of data on forage fish density (g/m^3) from hydroacoustic surveys and colony measurements of seabird population trends, breeding success, diet and behavior continues to provide a unique and important understanding of the response of seabirds to changes in oceanographic conditions (e.g. Arimitsu *et al.* 2021; Harding *et al.* 2007 a, b; Marsteller *et al.* 2024; Piatt *et al.* 2007; Schoen *et al.* 2024; Shultz *et al.* 2009).

Post heatwave studies of local forage fish communities and the seabirds breeding on Duck Island and Chisik Island suggest that impacts of the northeast Pacific marine heatwave of 2014-2016 on seabirds and their forage base have continued for several years beyond the heatwave itself (Arimitsu *et al.* 2021; Schoen *et al.* 2024; Marsteller *et al.* 2024). Population counts (both whole-island census and population plot counts) show that both Common Murre and Black Legged Kittiwake populations on Chisik Island and Duck Island had declined by more than 70% between the late 1990s and the 2010s (Arimitsu *et al.* 2021). Continued monitoring of seabird populations on Chisik Island and Duck Island is required to assess continuing impacts and recovery from the 2014-2016 heatwave.

In recent years, large die-offs of Common Murre have been documented in the Alaska marine ecosystems during the 2014-2016 Pacific Marine Heatwave (PMHW; Piatt *et al.* 2020). Based on the recovery of dead common murrens on beaches, Piatt *et al.* (2020) estimated

conservatively that about 0.5-1 million murrens died in Alaska marine ecosystems during the 2014-2016 PMHW, or 10-20% of the North Pacific population.

While there are several sites in the Gulf of Alaska and Bering Sea where common murre breeding success and population trends are monitored, the only current study of common murre survival in the Pacific occurs on Duck Island and Gull Island (Kachemak Bay). The continued collection of these data are crucial to both model and understand the recovery of murre populations from the 2014-2016 heatwave and predict the future response of murrens to global warming.

Summary

- The Rock Sandpiper *Calidris p. ptilocnemis* is a subspecies of high conservation concern, and the tidal flats in Tuxedni provide important feeding habitat for these birds during extremely cold winters (Ruthrauff *et al.* 2013).
- Cook Inlet supports a high percentage of the Pacific Flyway population of Western Sandpipers during the Spring migration, and Tuxedni is an important stopover site for these birds on their northward migration (Gill and Tibbitts 1999).
- Chisik Island and Duck Island support locally important populations of breeding seabirds, and the long-term data sets from these sites are providing a unique and vitally important understanding of the response of seabirds to oceanographic change in the North Pacific. This understanding is especially important given the global declines of seabird populations (Paleczny *et al.* 2015).

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