

VARIATION AND DISTRIBUTION OF GLAUCOUS GULLS IN WESTERN ALASKA

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Many gulls have been collected in western Alaska that are intermediate in coloration between the Glaucous Gull (*Larus hyperboreus*) and darker-winged gulls. These intermediates, originally named *L. nelsoni* (Henshaw 1884) have proven difficult to classify. Dwight (1906) and Bent (1921) accepted *nelsoni* as a species, although Dwight later (1925) regarded it as a hybrid between *hyperboreus* and the Herring Gull (*L. argentatus*). Swarth (1934), in his discussion of specimens from Nunivak Is., mentioned that all those he called Glaucous-winged Gulls (*L. glaucescens*) and some called *hyperboreus* were, in fact, intermediate between the two in darkness of mantle and pigmentation of primary remiges. Ingolfsson (1970) examined specimens of *hyperboreus* collected throughout arctic North America and found that 25% of the Alaskan birds appeared to be hybrids, as opposed to 1% in Canada. He suspected that the birds were *argentatus-hyperboreus* hybrids, the result of an occasional *argentatus* wandering from Siberia. The principal breeding range of *hyperboreus* reported in the literature does not overlap with those of *glaucescens* and *argentatus* (Fig. 1). Where *glaucescens* and *argentatus* are sympatric around Cook Inlet and extreme southeastern Alaska, those two forms interbreed (Williamson and Peyton 1963, Patten and Weisbrod 1974).

While conducting a behavioral study of Glaucous Gulls in western Alaska, I discovered a great deal of variation in the color patterns of irises, eye-rings and primary feathers of adults. The variation appeared great enough to be the result of hybridization with a darker form. Some variation in darkness of juvenile plumage and bill color was also present. This paper describes and discusses the variations, and presents some new distributional information.

METHODS

I studied Glaucous Gulls and hybrids on their breeding grounds in two areas within the Clarence Rhode National Wildlife Range: at Kokechik Bay in 1972 and 1973, and in the Kashunuk River area in 1974. Specimens were taken near nests, near feeding areas, or between the two. Usually the first bird taken in a sample of four to eight was the first to fly within shotgun range; the other gulls in the vicinity then

circled the downed individual, and the remaining birds in the sample were collected. When examining gulls with a 30× spotting scope, I was unable to distinguish between phenotypic *hyperboreus* and hybrids, so I probably made no subconscious selection in the composition of the samples. The possibility remains, however, that hybrids and phenotypic *hyperboreus* varied in susceptibility of collection. Attempts to collect gulls by means of drugs proved unsuccessful; the birds apparently preferred the abundant tundra voles (*Microtus oeconomus*) to my drugged sardine baits.

Between 25 March and 15 April 1974 I observed Glaucous-winged Gulls on Adak Is. in the Aleutians. I collected specimens while they fed at dumps or flew past wind-deflecting dunes.

Munsell Color Charts (Matte Finish Collection, Neighboring Hues Edition) were used to measure iris and eye-ring color of specimens.

Values of Ingolfsson's (1970) wing hybrid index, from 0.0 (pure *hyperboreus*) to 5.0 (pure *glaucescens* or *argentatus*) were assigned to each bird. The tips of *hyperboreus* primaries are white, those of *glaucescens* dark gray (Munsell value 4), and those of *argentatus* black, with presumed hybrids having variable amounts of dark pigment (Fig. 2).

I made an aerial survey along the Bering Sea coast on 9 September 1974, between Hazen Bay and the Kuskokwim River, counting the adult and young gulls seen. I also observed gulls feeding in the Bethel dump on 9 and 12 September 1974. On 9 July 1974 I saw Cape Romanzof, the reported site of a *glaucescens* colony (Brandt 1943), from the air.

RESULTS

Wing hybrid indices (Fig. 2) indicate that a high proportion of the large gulls of the Kokechik and Kashunuk areas deviate from the pure *hyperboreus* phenotype. The mean wing hybrid index was slightly higher for Kokechik birds (0.35 vs. 0.24), and a slightly larger percentage of the Kashunuk sample had a hybrid index larger than 0.0 (62 vs. 53%), but neither difference was statistically significant ($P > 0.05$). Of the thirteen *glaucescens* collected on Adak Is., twelve had hybrid indices of 5.0; the thirteenth was 4.8. As in the Iceland hybrids (Ingolfsson 1970), the tenth (outermost) primary of Kokechik-Kashunuk birds was darkest.

Irises of Adak gulls, with one exception, showed a salt-and-pepper pattern of fine yellow and dark brown spots. The exceptional iris was clear yellow, but most were at least 75% dark brown (Munsell hue 5YR-10YR, value 3-8, chroma 2-6). The distributions of hue and value for the yellow spots were sim-

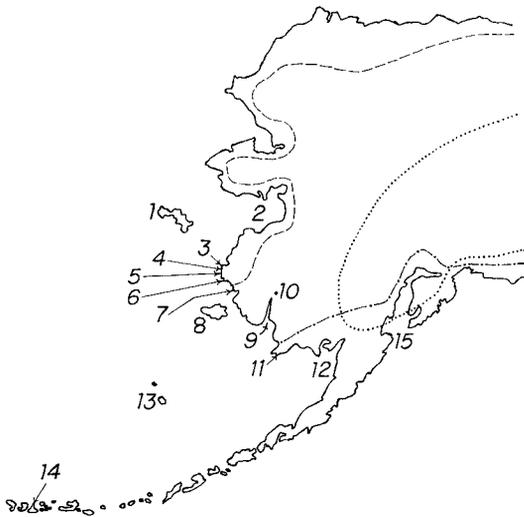


FIGURE 1. Alaska reference map. (1: St. Lawrence Is.; 2: Norton Sound; 3: Cape Romanzof; 4: Kokechik Bay; 5: Hooper Bay; 6: Kashunuk River; 7: Hazen Bay; 8: Nunivak Is.; 9: Kuskokwim Bay; 10: Bethel; 11: Cape Pierce; 12: Bristol Bay; 13: Pribilof Islands; 14: Adak Is.; 15: Cook Inlet. The principal mainland breeding ranges of *Larus hyperboreus*, *L. argentatus* and *L. glaucescens* were derived from sources listed in the Discussion and are bounded by dashes, dots, and dashes-and-dots, respectively. The aerial survey followed the coast between points 7 and 9. The coastal area between points 7 and 11 has not been well explored ornithologically.)

ilar to those of the Kokechik-Kashunuk birds (Fig. 3), but the chroma was lower in the Adak birds.

Since adult Glaucous and Herring gulls in other parts of the world have clear yellow irises (Smith 1966, Ingolfsson 1970), the appearance of dark brown pigment in the irises of Kokechik-Kashunuk birds in a highly variable manner might be the result of hybridization with the Glaucous-winged Gull. A new composite hybrid index can be created if the deposition of dark pigment in primaries and irises is independent. Otherwise the same alleles may control both, and the wing hybrid index suffices. A contingency table showed no statistically significant relationship ($P > 0.10$) between dark pigment deposition in primaries and irises. Six classes of iris (percent of iris darkly pigmented: 0, 1-20, 21-40, 41-60, 61-75, 76-100) were assigned values of 0-5. These iris values and the six wing hybrid index classes gave, if summed for each bird, a composite hybrid index of 0.0 for a phenotypic pure *hyperboreus*, 10.0 for a *glaucescens*. On the basis of the composite hybrid index (Fig. 4), only 28% of the Kokechik-Kashunuk gulls for which I had both iris and

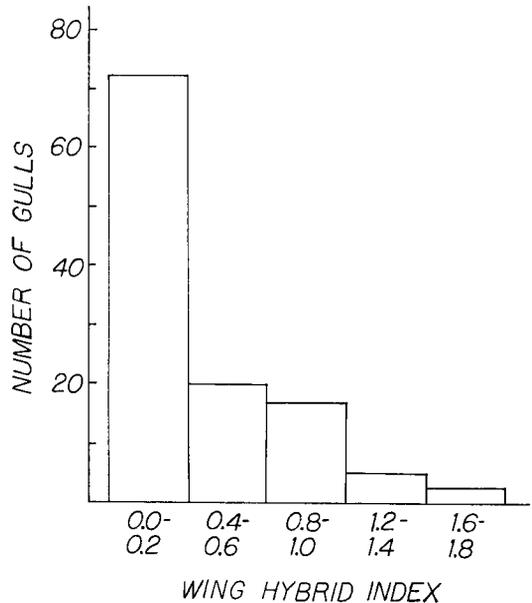


FIGURE 2. Frequency histogram of variability in amount of dark pigment in outer primary remiges of large *Larus* gulls collected at the Kokechik and Kashunuk study areas. (Wing hybrid index based on Ingolfsson [1970]; 0.0 = pure *hyperboreus* phenotype, 5.0 = pure *glaucescens* phenotype.)

wing measurements had a pure *hyperboreus* phenotype. Only one gull had a composite hybrid index closer to *glaucescens* than to *hyperboreus*.

Eye-ring color in all of the Adak gulls and some of the Kokechik-Kashunuk birds was a dull violet-brown. The remaining Kokechik-Kashunuk birds had some yellow in the eye-ring, but this seemed gradually to be replaced by violet-brown as the summer passed. Johnston (1956) found that eye-ring color varies seasonally in the California Gull (*L. californicus*), so it is possible that some Adak birds would have exhibited yellow eye-rings if they had been collected later in the season. Glaucous Gulls elsewhere have yellow or orange eye-rings (Smith 1966, Ingolfsson 1970).

Large gulls were distributed all along the coast in the area covered by the aerial survey (Fig. 1), which was made on a brilliant day after the young were flying. The sun made all birds appear white, so that juveniles were difficult to distinguish. At least 10% of the large gulls observed were juveniles, though, distributed all along the coast from Hazen Bay to Kuskokwim Bay. Assuming that the birds had not travelled great distances shortly after fledging, then the breeding range of large gulls is essentially continuous in the area covered by my survey.

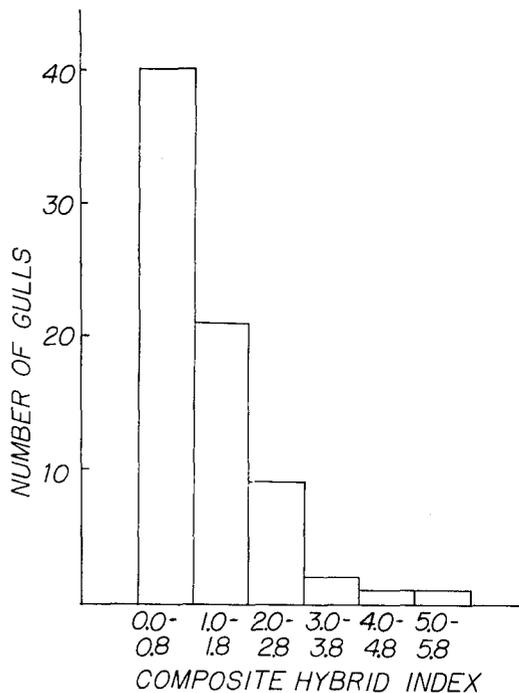
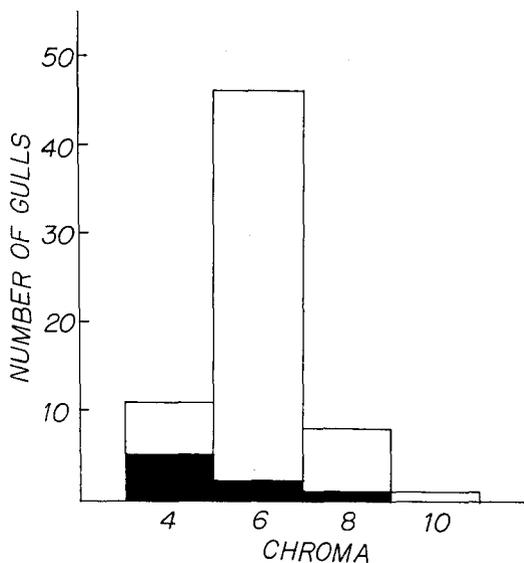
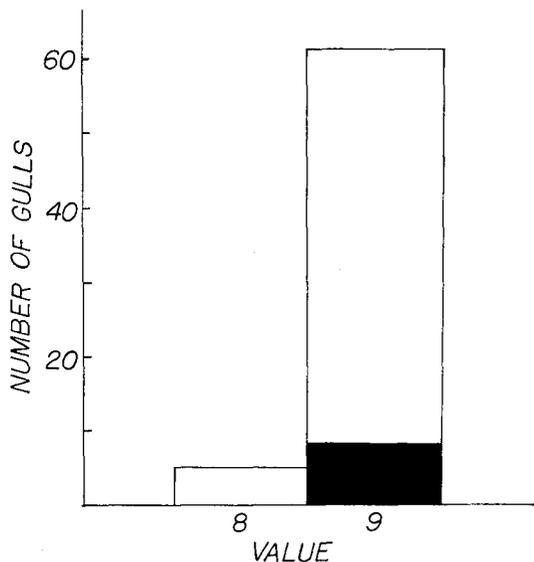
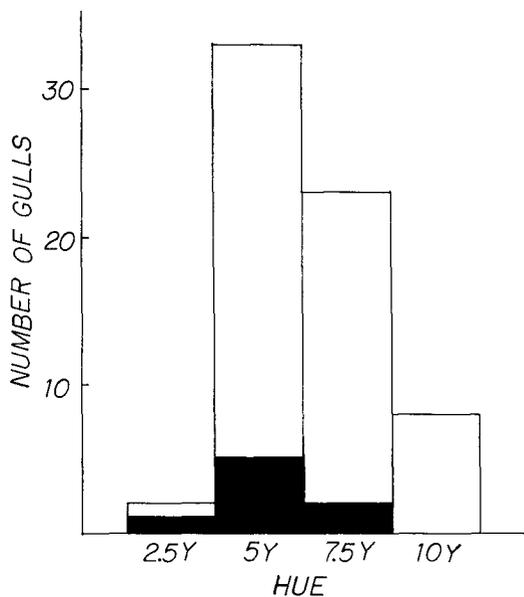


FIGURE 4. Frequency histogram of large *Larus* gulls collected on the Kokechik and Kashunuk study areas. (Hybrid index a sum of Ingolfsson's [1970] hybrid index for primary remex pigmentation, and a measure of the amount of dark pigment in the iris. 0.0 = pure *hyperboreus* phenotype; 10.0 = pure *glaucescens* phenotype.)

The Bethel dump was crowded with *Larus* young of the year. At least one-third of these were *hyperboreus*-like, pale with black-tipped pale bills. At least one-third were like *glaucescens* juveniles, dark with black bills (Johnston 1955). The only adult present was a *hyperboreus*.

The only gulls I saw at Cape Romanzof were a few individuals foraging along the edge of the sea. I saw no evidence of nesting; a few slender pinnacles were the only clifflike formations breaking the uneven, talus-covered hillside.

DISCUSSION

The Glaucous Gull breeds along the coast and on islands of arctic and northwestern Alaska (various records cited in Gabrielson and Lincoln 1959), south at least as far as the

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FIGURE 3. Frequency histograms of iris color measurements for large *Larus* gulls. (Hue, value and chroma are measurements which define a color in the Munsell color system. Open bars represent Kokechik-Kashunuk birds, dark bars represent Adak Island birds.)

Kashunuk River (this report) and probably to the Kuskokwim River where it is at least present in summer (Walkinshaw and Strophlet 1949, Williamson 1957, this report). A few nests were reported by Hurley (1931) at Bristol Bay, but the range of the species is not continuous to that point, as Dick and Dick (1971) found only *glaucescens* nesting in the Cape Pierce region.

The Herring Gull is coastal in extreme southeastern Alaska (Patten and Weisbrod 1974), the Cook Inlet area (Williamson and Peyton 1963) and on St. Lawrence Is. (Fay and Cade 1959). Elsewhere it is found inland (Gabrielson and Lincoln 1959).

In Alaska, the Glaucous-winged Gull nests along the coast and on islands throughout the southeastern part of the state, the Alaska Peninsula and Aleutian Islands, the Pribilofs (Gabrielson and Lincoln 1959), north along the coast at least as far as Cape Pierce (Dick and Dick 1971), and perhaps to the Kuskokwim River (Cady et al. 1955). It is also said to breed on St. Lawrence Is. (Brooks 1915), in Norton Sound (McGregor 1902), and at Cape Romanzof (Brandt 1943), but close examination of those records does not sufficiently support the authors' contentions. As mentioned above, the hillsides of Cape Romanzof do not appear to be suitable nesting habitat for *Larus* gulls, and none nested there in 1974. Recent investigators (Friedmann 1932, Murie 1936, Fay and Cade 1959, Sealy et al. 1971) have not found breeding *glaucescens* on St. Lawrence Is., although Sealy did see a few adults. The remaining isolated northern breeding report for *glaucescens* is that of McGregor (1902) in Norton Sound. He collected no adults in the northern site and failed to mention *hyperboreus*, which probably was present in abundance.

The coastal area between Cape Pierce and Hazen Bay (Fig. 1) has not been well explored ornithologically. I know of no ground studies, but as mentioned above, large gulls were abundant between Hazen and Kuskokwim bays in early September 1974. If the phenotypically intermediate gulls reported in this paper are *hyperboreus-glaucescens* hybrids, mixed pairs should be present somewhere in that relatively unexplored strip of coast. Ground surveys, including temporary immobilization or collection of breeding pairs, are in order.

Hybridization between different forms of birds where their ranges meet is often reported; many examples are listed by Short (1969). Hybridization is particularly common

among the large gulls. Western Gulls (*L. occidentalis*) and Glaucous-winged Gulls interbreed in Washington (Scott 1971), and the latter species forms mixed pairs with the Herring Gull in Cook Inlet and southeastern Alaska (Williamson and Peyton 1963, Patten and Weisbrod 1974). Ingolfsson (1970) found that the recent invasion of Iceland by *argentatus* has been followed by extensive hybridization between that species and *hyperboreus*. Apparent hybrids between *argentatus* and the Great Black-backed Gull (*L. marinus*) have also been reported (Jehl 1960, Andrlé 1972). In most of these cases, the species involved are sympatric in some parts of their ranges without interbreeding, maintaining their status as legitimate species (Short 1969).

N. G. Smith (1966) found that *hyperboreus*, *argentatus*, Thayer's Gulls (*L. thayeri*) and Iceland Gulls (*L. glaucoides*) nesting on Baffin Is. have developed completely effective isolating mechanisms. In the face of the extensive hybridization occurring elsewhere among *Larus* gulls, it would be interesting to find what factors have given a selective advantage to those Baffin Is. birds which select conspecific mates. Possibly the Baffin Is. birds have coexisted longer, and the hybridizing pairs will eventually become isolated. Hybridization can occur at low densities of two related sympatric forms, the scarcity of mates making hybridization advantageous (Short 1969).

The wings of many birds collected in the Kokechik-Kashunuk area were intermediate between *hyperboreus* and *glaucescens*. Not one had a trace of black, which would be expected if *argentatus* were the source of variation. Furthermore, I observed none of the latter species during my three years at the tip of the delta, although one subadult individual in the Bethel dump may have been an *argentatus*. They are too rare in the area to cause so many hybrid phenotypes. Although *hyperboreus* has yellow irises elsewhere, a significant percentage of the Kokechik-Kashunuk birds' irises had dark pigment. *Larus glaucescens* has a dark iris; that of *L. argentatus* is yellow.

One problem in arguing for interbreeding of *glaucescens* and *hyperboreus* is the lack of evidence of *hyperboreus* genetic influence in *glaucescens* populations to the south. Few *glaucescens* specimens have been collected just north of the Alaska Peninsula, where hybrids would be most common. Dick and Dick (1971) saw only one gull at Cape Pierce with

light irises, but noted that "some appeared to have much lighter primaries than others." An almost complete absence of alleles for dark iris pigmentation may be necessary to produce irises that are obviously pale when viewed from a distance. Also, gene flow may be occurring at a greater rate in the south-to-north direction.

SUMMARY

Glaucous Gulls in western Alaska vary in pigmentation of iris, eye-ring and primary remiges. This variation has been attributed to hybridization of Glaucous Gulls with Glaucous-winged or Herring Gulls by various authors. The distribution of these species in western Alaska is incompletely known.

This paper describes gulls collected in the area of the Kokechik and Kashunuk Rivers in western Alaska. Many are intermediate between Glaucous and Glaucous-winged gulls in color of iris and primaries, with only 28% displaying pure Glaucous Gull phenotype.

Glaucous Gulls may breed along the coast between the Kokechik-Kashunuk area and the Kuskokwim River to the south. Juvenile Glaucous and Glaucous-winged gulls were present at Bethel, on the Kuskokwim, in September 1974. Isolated breeding records for Glaucous-winged Gulls north of the Kuskokwim have not been substantiated, but ornithological surveys are incomplete for coastal western Alaska.

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