Alutiiq Ancestors' Use of Birds During the Ocean Bay Period at Rice Ridge (49-KOD-363), Kodiak Island, Alaska

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Abstract. Rice Ridge (49-KOD-363) is a deeply stratified archaeological site on Kodiak Island, Alaska, with well-preserved faunal remains from three occupations dating to the Ocean Bay tradition. The site contained an extensive bird-bone assemblage analyzed here for the first time. Casperson (2012) studied bird bones from Mink Island (49-XMK-030), also located in Alutiiq/Sugpiaq territory, and found that birds played important roles in the lifeways of Ocean Bay groups, even though these people have been portrayed as primarily dependent on marine mammals and fish. At Rice Ridge, cormorants, ducks, murres, and geese (among other birds) were vitally important to Alutiiq ancestors, especially during the winter. The relative abundance of birds differs across the three occupations at Rice Ridge, although these differences resist easy explanation. What is clear is that Alutiiq ancestors consumed birds as food and also processed quantities of bird skins for clothing that was crucial to their survival.

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In Archaeo-Ornithology (Kost and Hussain 2019) and Ethno-Ornithology (Funk 2018), zooarchaeologists recognize that human relationships with birds can encompass use as food, as materials to be made into tools and clothing, as indicators of ecological conditions, or as supernatural forces to be respected and petitioned. The Rice Ridge avifaunal assemblage is a culturally mediated collection (sensu Funk 2018:145–146) based on the social relationships between Alutiiq ancestors and birds. We cannot know how Ocean Bay tradition people perceived birds, how they assessed their characteristics, or how they classified them. However, archaeological study of the Rice Ridge bird bones does allow us to evaluate which birds Alutiiq ancestors obtained, and to some extent, how they used them—for food and for materials used to make tools, clothing, and adornment. As we will show, Alaska Native traditional ecological and ethnographic knowledge is essential for interpreting the archaeological patterning at Rice Ridge.

Kodiak is the largest island in the Gulf of Alaska, separated from the mainland by Shelikof Strait, a ∽40 km stretch of treacherous ocean. Kodiak Island is the center of Alutiiq/Sugpiaq territory, extending from Prince William Sound to the outer Kenai Peninsula, Kodiak Archipelago, and the Alaska Peninsula. Kodiak islanders live within a rich coastal and marine environment, although terrestrial resources are fewer. Marine mammals that inhabit Kodiak waters include seals, sea lions, sea otters, whales, dolphins, and porpoises. People also had access to marine and anadromous fish, including Pacific cod and other gadids, several species of salmon, greenlings, flatfish, rockfish, sculpins, and herring. Despite the high resource productivity throughout much of the year, Fitzhugh (2002:264) characterized winter as a season of scarcity:

> In the Kodiak Archipelago today, winter is a much more difficult period in which to secure food than spring, summer, or fall. The most productive resources (salmon, adult halibut, migratory waterfowl, and sea mammals) leave the region or are at least less accessible during this period (minimally November to April). Combine this with a tendency for much more extreme weather in winter, and foragers would be forced to subsist in winter primarily on a handful of locally available bottom fish, sea birds, and shellfish (Fitzhugh 2002:269).

Although winter weather at high latitudes does constrain people's activities, this evaluation does not clearly acknowledge the importance of the Kodiak Archipelago as a wintering place for birds from surrounding regions. In winter, ocean currents moderate temperatures, providing Kodiak the greatest diversity of wintering birds in Alaska (MacIntosh 2009:3). Kodiak provides critical winter habitat for more than a million sea ducks and other migratory birds that nest in western and northern Alaska (MacIntosh 2009:2–3). Although some migratory waterfowl from Kodiak head south in the winter, others from across the Arctic, including many from the Yukon-Kuskokwim Delta, winter in Kodiak waters. In this paper, we present evidence that Rice Ridge was occupied during winter and that birds provided critical overwintering resources to Alutiiq ancestors throughout the Ocean Bay tradition. The bird assemblage indicates that occupation was not limited to winter, however, and birds were taken during other seasons as well. More than 240 species of birds have been identified in the Kodiak Archipelago (ADFG 2020), and this rich seasonal diversity has supported Alutiiq ancestors for thousands of years.

Site and Assemblage History

At the time it was excavated (1988–1990), the Rice Ridge archaeological site was the only site on Kodiak Island of Ocean Bay age (5600–2200 BC) that contained well-preserved faunal remains and organic artifacts (Hausler Knecht n.d.a:10). This remains true today (Amy Steffian, personal communication 2021). For the site background described here, we rely heavily on Kopperl (2003, 2012) but also draw from records of the University of Washington Burke Museum and the Alutiiq Museum and Archaeological Repository. The site is located about 20 km south of the city of Kodiak, along the shores of Chiniak Bay (Fig. 1). It is positioned an estimated 300 m from the modern shoreline, but at the time of occupation, it was situated along the former shoreline of a now-drained lagoon, as the east side of the island has been rising (Knecht 1995:106). Following Fitzhugh's (2002:265) site-location typology, Rice Ridge is in a good location "mid-bay" along the south side of the large Chiniak Bay, which is comprised of several smaller estuaries, adjacent to the head of Isthmus Bay, and ∽8 km from the head of Kalsin Bay (Fitzhugh's "inner bays"). Rice Ridge is only 10 km from Cape Chiniak and the outer coast, giving it good access to summer "hot spots" (i.e., resource concentrations) (Fitzhugh 2002:265–266).

Site deposits occur over a 100 m by 30 m area but are best known in the northeastern portion of the site, where excavations occurred on the point of a ridge (Fig. 2). The site was excavated during three field seasons in 1988, 1989, and 1990 by then Harvard graduate student Philomena Hausler-Knecht and a crew of several individuals that included Don Clark, Rick Knecht, Marie Rice, Phillip McCormick, Katie Wenzel, Susan Wenzel, Ronnie Rogers, and Jenny Factor, among others.

The crew tested at least four areas of the site, although here, we focus on those units that were

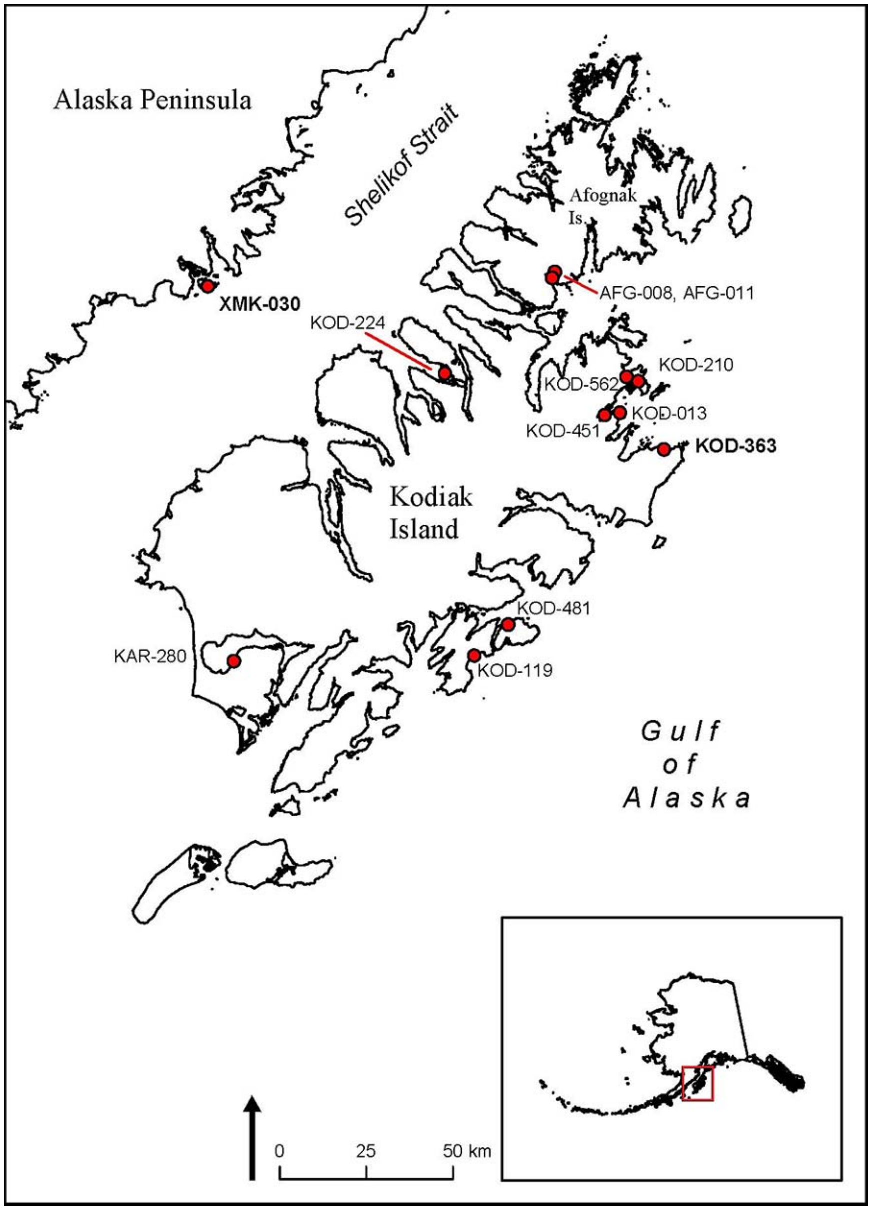

Figure 1. Sites with Ocean Bay components in the Kodiak Island vicinity, including Rice Ridge (49-KOD-363) and Mink Island (49-XMK-030), following Kopperl (2012:18), by Molly Casperson.

part of a 10x4-m block (made up of 2x2-m squares) in the northeastern portion of the site. Initially, five radiocarbon assays were obtained from various parts of the site. Although Hausler-Knecht never completed a site report or publication on Rice Ridge, she wrote proposals in 1988 and 1990 to landowners Marie and Dale Rice with her excavation plans, as well as two manuscripts and presented a few conference papers that included some preliminary results of the excavations. Although these writings reveal Hausler-Knecht's interests in a variety of research questions, her dissertation plans were focused primarily on the artifacts and aspects of Kodiak culture history and prehistory. In 1993, Hausler-Knecht (n.d.a:10) estimated she had recovered ∽2,600 artifacts, half of which were bone tools. In the northeastern block, she and her crew found cultural material beginning at depths between 50 cm and 80 cm below the ground surface, extending down to 240–260 cm below the surface. Excavation proceeded according to natural stratigraphic levels, revealing areas of "midden" (including shell midden) and a series of "red ochre covered surfaces complete

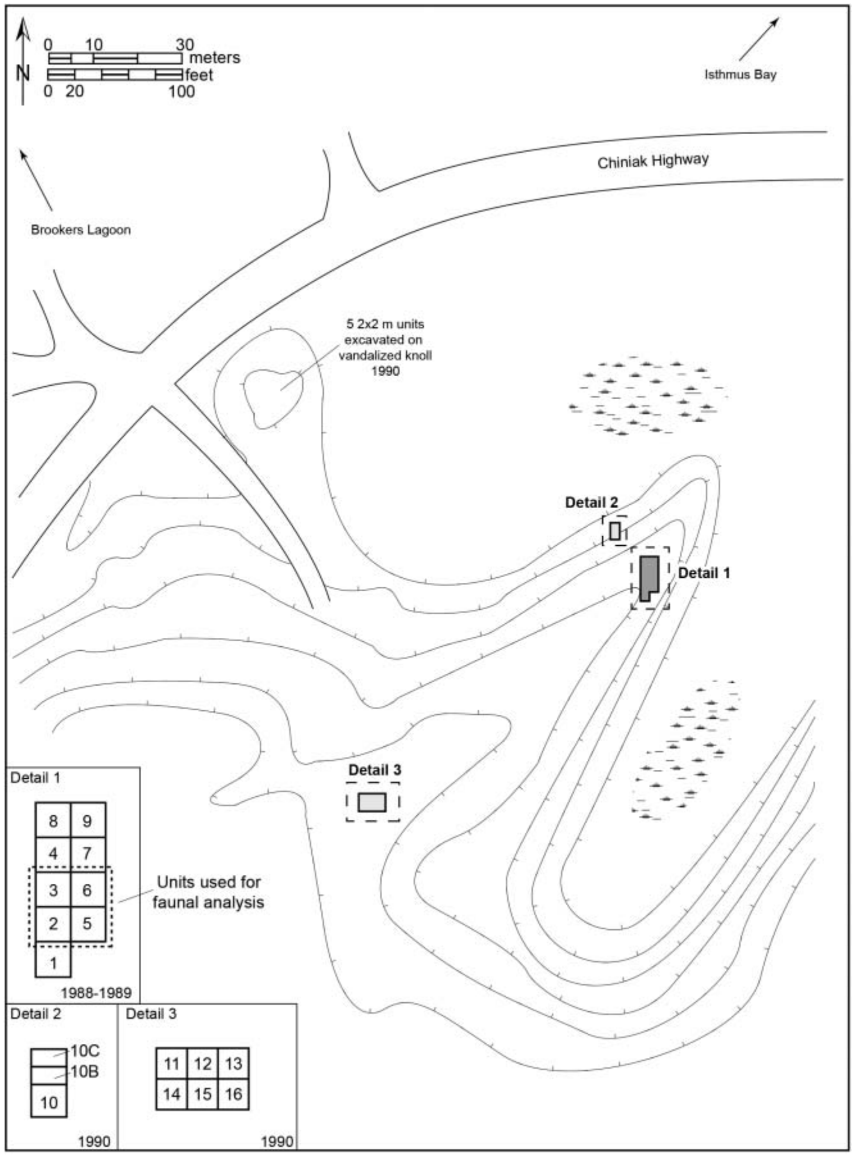

Figure 2. Configuration of excavation units at Rice Ridge (49-KOD-363) by Robert Kopperl, used with permission.

with postholes and rectangular slab hearths in the northeastern units" (Hausler-Knecht n.d.b:2). Hausler-Knecht (n.d.b:4) explained that the floors excavated at Rice Ridge

> were not simply stained with ochre, but rather, uniformly covered with a very oily coating of red ochre. This coating was sometimes applied to the sides of the hearth rocks as well.

Red-ochre processing tools were also found in the deposits, including "grooved ochre grinding slabs" and "hand-held pounding stones" (Hausler-Knecht n.d.b:4). These floors were interpreted as living floors of surface structures (as opposed to semi-subterranean houses); Hausler-Knecht (1988:11) suggested that Ocean Bay people were occupying skin-covered tents at Rice Ridge.[1] Steffian (2001:107–108) described such early structures as lightweight skin tents with small post holes left by tent frames in an oval, circular, or tear-dropped pattern in the ground (see also Knecht 1995:106). Steffian suggested these structures were occupied by nuclear family groups, perhaps only seasonally. Features such as hearths were found at Rice Ridge; some were rectangular slab hearths, and others were circular.

Faunal remains were recovered by hand and using 1/4"mesh screens, which biases against the

Table 1. Rice Ridge (49-KOD-363) chronology for Excavation Units 2, 3, 5, 6, following Kopperl (2012).

Time Period					
Local	**Regional**	**Strata**	**cal. BC**	**cal. BP**	**Duration of Occupation**
Early	Ocean Bay I	K, J, I, H, G	5090–4780	7040–6730	~310 years
Middle	Ocean Bay I	F, E, D, C	3910–3770	5860–5720	~140 years
Late	Ocean Bay II	B, A	2960–2370	4910–4320	~590 years

Note: Kopperl (2012:26-27) reported age ranges at both 1-sigma and 2-sigma, with calibrated age-estimate curves of radiocarbon dates generated by OxCal 4.1 (Bronk Ramsey 2009).

recovery of small birds such as small alcids, among others. Hausler-Knecht (1990:26, 1993:10) estimated the number of identifiable faunal remains as 30,000 specimens. The extensive faunal remains were shipped across the country to Tom Amorosi at Hunter College, who was slated to analyze the fauna from Rice Ridge. These analyses were not accomplished, and in 1999, Robert Kopperl, then a graduate student at the University of Washington, went to Hunter College and inventoried the faunal collections from Kodiak. In 2000, Kopperl acquired the Kodiak faunal collections from Tom McGovern (Hunter College) and drove them back to Seattle in a 17 ft. U-Haul truck. At the University of Washington, Kopperl sorted out the mammal and fish bones from the Kodiak collections he analyzed, but later, he (and others) prepared the collections for curation at the Burke Museum. This included transferring provenience information written on field bags to new bags, spreadsheets, and museum catalogs.

For his dissertation, Kopperl (2003) analyzed and systematized the Rice Ridge site stratigraphy for the portion of the site he studied: excavation squares 2, 3, 5, and 6 in the northeastern portion of the site, excavated in 1988 and 1989. He obtained an additional 22 radiocarbon assays from this area, which allowed him to build a chronology. Kopperl defined 11 discrete analytical units (A-K), each of which is classified as either "midden" or "occupation surface." Kopperl's (2003) dissertation reported on the mammal and fish remains from four Kodiak sites to investigate if, over the course of Kodiak prehistory, people shifted from large prey (such as marine mammals) to more intensified use of smaller prey, such as fish. Looking at material from these four sites, extending from the early Ocean Bay period through later Kachemak and Koniag periods (AD 1200–1780), Kopperl did find evidence of intensification. He identified significant declines in ratios of sea mammals to both marine fish and salmon, suggesting a decline in foraging efficiency before the increase in cultural complexity that occurred during the Kachemak period (after 900 BC). From Rice Ridge, Kopperl (2003:167) identified more than 9,200 mammal and fish remains.

Since the 11 analytical units Kopperl defined (A–K) from units 2, 3, 5, and 6 are well-dated, we have focused our bird-bone analysis on these same excavation units. Kopperl (2012) refined the Rice Ridge chronology for these units, identifying three distinct occupations that span Ocean Bay I and II but not continuously. These periods (which do not incorporate Hausler-Knecht's five radiocarbon assays) are presented in Table 1. Kopperl (2012:29) noted, however, that human occupation of Rice Ridge extends as far back as 7600 cal. BP, based on Hausler-Knecht's radiocarbon assays. If an anomalous date from Stratum J were also included, site occupation might extend even further into the past to around 8000 cal. BP (Kopperl 2012:26).

In 2012, then University of Oregon graduate student Molly Casperson acquired the cataloged bird bones from the northeastern area of Rice Ridge on loan from the Burke Museum, with the intent of studying them as part of her Ph.D. research. Instead, Casperson's (2017) dissertation focused on faunal assemblages from Summit Island, located in Bristol Bay. In 2019, as part of her *Zooarchaeology* course taught at the University of Oregon, Madonna Moss began studying the Rice Ridge birds with her students (see Methods, below). The class project goals were to address standard research questions: What birds are represented at Rice Ridge? How were they used by site residents (for food, to make clothes, bone tools, etc.)? What habitats were site residents using? What time(s) of the year did Alutiiq ancestors occupy the site? How did bird use at Rice Ridge compare to that at the contemporary Mink Island site? Why are some of the bird bones at the site stained with red ochre? Were the remains (carcasses) of different bird taxa treated differently when they were discarded? Herein we address some but not all of these research questions.

In her writings, Hausler-Knecht emphasized that the Rice Ridge artifact assemblage contained a large number of bone tools, including bird-bone tools. She noted "hundreds of fine bone needles and delicate awls" (Hausler-Knecht n.d.a:13), which are now curated at the Alutiiq Museum. The bird bone needles had incised eyes. Also found were bird bone pendants, beads, a whistle, and some finely carved objects that could be finger pegs from atlatls (Hausler Knecht n.d.b:9). Hausler-Knecht (n.d.b:6) also noted a "fair number of eagle or raven talons." Although we identified five eagle talons, additional talons may be held in the Alutiiq Museum artifact collections (although none were noted in the extant artifact catalogs provided by Amy Steffian, personal communication 2021). We have not studied the bird bones made into artifacts, only those that were considered unmodified "faunal remains." Similarly, we have not analyzed any of the Rice Ridge artifacts (bone or lithic) that may have been used to hunt, trap, or process birds. Our analyses are limited to bird remains recovered from the four excavation units studied by Kopperl, which comprise just one portion of the excavated assemblage.

Methods

Faunal analysis of the Rice Ridge birds began during the Winter term of 2019, with students taking *Zooarchaeology*. Working on a single provenience at a time, the procedure was to sort bones by element, separating out the unidentifiable elements. Long-bone shaft fragments missing both proximal and distal ends were considered unidentifiable unless they could be refit with a proximal or distal end in the bag from the same provenience. Elements identified included from the head (cranial fragments, premaxillae, mandibles), torso (coracoids, furcula, scapulae, sterna, synsacra), wings (humeri, radii, ulnae, carpometacarpi, phalanx I of digit II, ulnae, scapholunars), and legs (femora, tibiotarsi, tarsometatarsi). We did not identify ribs, vertebrae, or most phalanges, although pygostyles and claws (terminal phalanges) were identified if sufficiently complete. Element and taxonomic identifications were made using the University of Oregon Department of Anthropology North Pacific Comparative Collection, as well as specimens graciously lent by the Ornithology Laboratory of the University of Washington Burke Museum. Published osteology guides by Cohen and Serjeantson (1996), Gilbert et al. (1996), and Post (2005) were used, and the VZAP (2020) and Idaho State Museum (2020) online sources were consulted. Specialized literature was accessed, including protocols devised by Bovy (2005), Broughton (2004), and Woolfenden (1961), as well as data presented in Bedetti and Pavia (2007) and Li et al. (2014). In the descriptions that follow, we rely on local names in common usage but make reference to the American Ornithological Union Check-list (Chesser et al. 2020) as needed for clarity. The local names are also the ones most frequently used in the biological literature relied upon here.

If bones were so dirty they were tough to identify, they were gently brushed with a dry toothbrush or gently washed in water and brushed with a toothbrush. Bones washed with water were dried on paper towel-lined trays overnight. We did not weigh bones, nor did we count bones unidentifiable to element. We did not record the 1,029 bones that were identifiable to element but too fragmentary to identify to a taxon. Because the assemblage was so large, we proceeded to wash all bones identified to element so they could be labeled with provenience information in pen and ink to facilitate sorting and identification to the taxon level. Bones stained with red ochre or other possibly culturally significant residues were not washed. This process began during the Winter term of 2019 and continued during the Spring term with three undergraduate students, Amy Shannon, Brittany Falconer, and Erick Wonderly. With her 2019 University of Oregon CURE Undergraduate Summer Research Fellowship, Amy Shannon spent eight weeks working on the project during the summer of 2019, along with volunteer Brittany Falconer. On the first sweep through the entire four excavation units-worth of bones, we identified all ducks and geese to anatid and then made more specific identifications by laying out comparative specimens, working one element at a time, following Casperson's (2009:34) anatid protocol, and under Casperson's supervision. Work continued into 2020 and 2021.

On Excel spreadsheets, provenience information, taxonomic identifications, and modifications were recorded, such as burning, cut marks, punctures, and the like. Cut marks are also recorded on element templates adapted from illustrations in Cohen and Serjeantson (1996). Strata designations (A–K) used by Kopperl were added to each line of data. Shannon's (2021) undergraduate honors thesis provides more details on methods and also describes skeletal-part representation and bone modifications in greater depth.

Geese are some of the largest birds identified in this study and the most abundant of large birds identified from Rice Ridge; hence, we were interested in identifying which geese species were present. Unfortunately, geese bones are difficult to identify to the species level using morphological criteria. In cases such as this, where morphological differences are not preserved or identifiable, stable isotope analysis can be used as an indirect method of taxonomic identification of archaeological remains where there are predicted dietary differences between groups (Clementz et al. 2009). In the Arctic today, most geese are exclusively terrestrial herbivores, relying on tundra vegetation, while emperor geese are more carnivorous and more reliant on marine resources, including invertebrates, marine grasses, and algae (Hupp et al. 2008:23), such that emperor geese can be distinguished from other geese using stable isotope analysis of bone collagen (Gorlova et al. 2015). Following this approach, we conducted stable isotope analysis on a subset of bones with the intent of distinguishing emperor goose from other geese in the Rice Ridge assemblage, assuming that the diets of present-day geese can be extended to the past. The principles underpinning stable isotope analysis are well known (Kelly 2000). Carbon isotopes (δ^{13}C) in animal tissues reflect carbon fixed by plants at the base of the food web, predominately C_3 plants in high latitude environments. Aquatic C_3 plants tend to have higher δ^{13}C compared to terrestrial C_3 plants due to differences in carbon source (dissolved bicarbonate in marine systems) and CO_2 diffusion (Kelly 2000), and consequently, marine consumers, such as seabirds, often have higher δ^{13}C than terrestrial feeders. Nitrogen isotopes (δ^{15}N) in animal tissues reflect several processes related to available nitrogen sources and animal biology (nutrient intake, digestive, and excretory physiology) but tend to increase with trophic level (Kelly 2000; Newsome et al. 2010). Marine food webs typically have more trophic levels compared to terrestrial ecosystems, and consequently, marine consumers such as seabirds have higher δ^{15}N than terrestrial taxa (Kelly 2000). We also calculate the carbon isotopic offset between the carbonate and collagen components of bone ($\Delta^{13}C_{carb\text{-}coll}$), which differs between herbivores and carnivores (Clementz et al. 2009). This approach relies on the isotopic distinction between bone carbonate (higher δ^{13}C), which reflects the whole diet including carbohydrates, lipids, and proteins, while bone collagen (lower δ^{13}C) only reflects dietary protein (Tieszen and Fagre 1993). Lipids tend to have lower δ^{13}C compared to other dietary carbon sources, such that bone carbonate of animals consuming lipid-rich diets, such as diets including more animal and/or marine resources, are expected to have lower δ^{13}C, and thus lower $\Delta^{13}C_{carb\text{-}coll}$ (Clementz et al. 2009; Tieszen et al. 1983). Marine carnivores have been shown to exhibit especially low $\Delta^{13}C_{carb\text{-}coll}$ (Clementz et al. 2009). Taken all together, these various isotopic patterns indicate that Rice Ridge marine and terrestrial feeders are likely to be isotopically distinct such that emperor geese if they are marine feeding, are expected to be distinguishable from other geese. In addition to geese, we include cormorants in our study, as modern cormorants are marine consumers, feeding on marine fish and invertebrates, thus providing an excellent baseline for investigating the diets of geese (Gorlova et al. 2015; Shannon 2021:9, 15–20 for additional details).

We conducted isotopic analyses of bone collagen and carbonate of Rice Ridge cormorant ($n = 8$) and goose ($n = 8$) specimens. Bone was prepared for isotopic analysis following established procedures for bone collagen (δ^{13}C, δ^{15}N) (Sealy et al. 2014) and bone carbonate (δ^{13}C, δ^{18}O) (Crowley and Wheatley 2014; Garvie-Lok et al. 2004). Isotopic analysis of bone collagen was conducted using an elemental analyzer (Eurovector EA3000) coupled to an isotope ratio mass spectrometer (Nu Horizon 2). Reproducibility of δ^{13}C (±0.2‰) and δ^{15}N (0.4‰) was assessed using standards including USGS-40 (L-glutamic acid), USGS-41A (L-glutamic acid), and an animal gelatin (collagen) standard. Isotopic analysis of bone carbonate was conducted using a GasBench II (Thermo) coupled to an isotope ratio mass spectrometer (Thermo MAT 253). Reproducibility of δ^{13}C (±0.2‰) and δ^{18}O (0.4‰) was assessed using a variety of powdered carbonate standards, including IAEA-CO-8 (natural carbonatite), USGS-44 (high-purity calcium carbonate), and Elemental Microanalysis B2214 (Carrara marble).

For intra- and intersite comparisons, we focused on the four main bird groups: cormorants, murres, ducks, and geese, and we lumped together all other taxa into one group, "other," due to the small sample sizes of most other taxa. We used Chi-Square (X^2) analysis to determine statistical significance and analyzed the adjusted residuals to see which groups of birds contributed most to the X^2, following the methods described and demonstrated by Butler et al. (2019). Our intersite comparison is limited to the bird assemblage from Mink Island (located on the Alaska Peninsula, Fig. 1), the only other sizeable bird assemblage dating from the Ocean Bay period in the Alutiiq/Sugpiaq region (Casperson 2009, 2012).

Results

A total of 4,763 bird bones were identified to element, and of these, 3,744 were complete enough to identify to taxon. Thirteen bird families are represented, comprised of 34 genera and 23 species. Table 2 presents the bird bones we identified for each of the three chronological periods defined by Kopperl (2012): Early Period and Middle Period (Ocean Bay I) and Late Period (Ocean Bay II). The taxonomic order and nomenclature in Table 2 follow Dickinson and Remsen (2013). In terms of total numbers (NISP), cormorants (29%) and ducks (28%) are both well-represented, followed by murres (15%) and geese (12%). Gulls, kittiwakes, loons, ptarmigan, various small alcids, grebes, eagles (bald and golden), raven, albatross, shearwaters, small shorebirds, and gyrfalcon were also identified.

Table 2. Summary of bird taxa from Rice Ridge (49-KOD-363) by time period.

		Ocean Bay I		Ocean Bay II	
Scientific Name	**Common Name**	**Early**	**Middle**	**Late**	**Total**
Anatidae					
Anatidae	Ducks, geese, swans	33	33	14	80
Cygnus columbianus	Tundra swan	—	1	1	2
Anserini	Goose	173	150	102	425
Branta bernicla	Brant	1	4	7	12
Anser albifrons	White-fronted goose	—	—	1	1
Anatinae - large	Ducks - large	40	47	18	105
Anatinae - small	Ducks - small	65	86	14	165
Mergini	Sea duck	94	64	44	202
Clangula hyemalis	Long-tailed duck	—	—	1	1
Somateria sp.	Eider	27	23	11	61
Somateria spectabilis	King eider	13	13	8	34
Somateria mollissima	Common eider	79	157	34	270
Polysticta stelleri	Steller's eider	9	14	10	33
Melanitta sp.	Scoter	12	30	8	50
Melanitta fusca	White-winged scoter[1]	20	26	4	50
Bucephala sp.	Goldeneye duck	2	10	—	12
Mergus sp.	Merganser	5	3	—	8
Histrionicus histrionicus	Harlequin duck	3	6	1	10
Aythya sp.	Pochard	5	6	1	12
Aythya collaris	Ring-necked duck	—	3	—	3
Anas sp.	Dabbling duck	6	14	4	24
Phasianidae					
Lagopus sp.	Ptarmigan	5	47	11	63
Lagopus cf. *lagopus*	Willow ptarmigan	—	—	1	1
Podicipedidae					
Podiceps sp.	Grebe	2	10	—	12
Podiceps cf. *auritus*	Horned grebe	—	3	—	3
Gaviidae					
Gavia sp.	Loon	2	2	4	8
Gavia immer	Common loon	37	53	11	101
Diomedeidae					
Phoebastria sp.	Albatross	8	3	—	11
Procellariidae					
Fulmarus glacialis	Northern fulmar	—	2	—	2
Ardenna sp.	Shearwater	2	1	—	3

(Continued)

Table 2. *(Continued)*

		Ocean Bay I		Ocean Bay II	
Scientific Name	**Common Name**	**Early**	**Middle**	**Late**	**Total**
Phalacrocoridae					
Phalacrocorax sp.	Cormorant[2]	529	433	113	1075
Charadiiforme	Shorebird	—	1	—	1
Scolopacidae	Sandpipers	6	4	—	10
Alcidae					
Uria sp.	Murre	193	313	57	563
Cerorhinca monocerata	Rhinoceros auklet	1	4	1	6
Fratercula sp.	Puffin	7	12	4	23
Ptychoramphus aleuticus	Cassin's auklet	—	2	—	2
Aethia psittacula	Parakeet auklet	1	17	—	18
Aethia cristatella	Crested auklet	1	85	2	88
Brachyramphus sp.	Murrelet	2	1	—	3
Cepphus columba	Pigeon guillemot	3	16	4	23
Laridae		10	20	5	35
Larus sp.	Gull	37	23	18	78
Rissa sp.	Kittiwake	3	8	1	12
Accipitridae					
Haliaeetus leucocephalus	Bald eagle	8	19	3	30
Aquila chrysaetos	Golden eagle	—	1	—	1
Falconidae					
Falco rusticolus	Gyrfalcon	—	1	1	2
Corvidae					
Corvus corax	Raven	3	6	1	10
Total		**1447**	**1777**	**520**	**3744**

[1] Following the American Ornithological Union Check-list (Chesser et al. 2020), the white-winged scoter is now *M. deglandi*.
[2] Following the American Ornithological Union Check-list (Chesser et al. 2020), pelagic, red-faced, and Brant's cormorant are in the genus *Urile,* and double-crested cormorant is in the genus *Nannopterum*.

Zooarchaeologists generally find a strong correlation between taxonomic richness (the number of identified taxa) and sample size (e.g., Grayson 1984:131–167). In general, as sample size increases, the number of taxa also increases in a log-linear fashion until it levels off when no new species are added (Bartosiewicz and Gal 2007:39). In considering the Rice Ridge bird assemblage, we use three data points: the subassemblages from the Early, Middle, and Late periods (Fig. 3). The smallest subassemblage is from the Late Period, and as expected, it is the least rich, with 28 taxa (NISP = 520). The Middle Period subassemblage is the largest, and as expected, it yielded the greatest number of taxa (38, NISP = 1,777). Yet, the Early Period subassemblage is less rich (with 30 taxa) than one would expect based on its relatively large size (NISP = 1,447). As illustrated in Figure 3, the Early Period data point falls below the regression line. As Bartosiewicz and Gal (2007:40) have shown for birds, when sample size increases, the number of taxa tends to increase and is visually represented in a steeply sloped regression line. This suggests that during the Early Period, Rice Ridge residents focused on fewer bird taxa than did their descendants in later time periods.

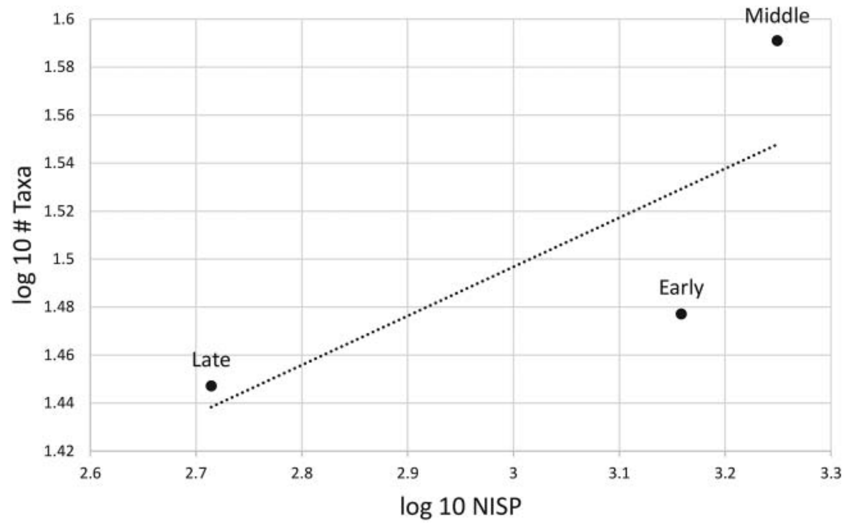

Figure 3. Relationship between sample size (NISP) and the number of bird taxa (richness) at Rice Ridge.

To measure taxonomic diversity, we used the reciprocal of the Simpson Index (Krebs 1989), which focuses on the equitability of abundances across taxa. Across groups of sites, this measure is often performed at the taxonomic level of families in an attempt to regularize across the varying identification methods used by different investigators (e.g., Bovy et al. 2019). Because the anatid family encompasses swans, several geese, and potentially more than three dozen ducks, lumping all of these as "anatid family" does not adequately capture the differences in taxonomic diversity across the Rice Ridge subassemblages. Instead, we included species- and genus-level identifications when figuring the index, but only if the genus was not already included in a species-level identification. For example, we included *Uria* sp. because we did not identify murres to species, and this category does not duplicate an identification to *U. aalge* or *U. lomvia*. However, we did not include *Melanitta* sp. because it is already represented by the identification of white-winged scoter (*M. fusca,* now *M. deglandi* in Chesser et al. 2020). We included the tribes Anserini and Mergini, the family Scolopacidae, and one small representative of the order Charadiiforme because these did not duplicate or encompass other categories. We did not include more generic identifications in this exercise, such as "large ducks" or "small ducks." This meant we were unable to include all identifications, but remarkably, the taxa retained and used in this exercise represented 86% of the NISP of each subassemblage. The Middle Period subassemblage (the largest) was the most diverse, with a reciprocal of the Simpson Index of 6.57. The Late Period subassemblage was also diverse, with a reciprocal of the Simpson Index of 6.51. The Early Period subassemblage was considerably less diverse, with a reciprocal of the Simpson Index of 4.27. We suspect that the greater diversity of the Middle and Late subassemblages is mainly due to the greater proportions of geese and ducks in these assemblages and the diversity among those birds. This result is consistent with that described above; during the Early Period, Rice Ridge residents were focusing on fewer, less diverse bird taxa than in the Middle and Late periods.

We compared the taxonomic representation of the four main groups of birds and "other" across the three dated occupations at Rice Ridge. Comparing the Early and Middle periods resulted in a $X^2 = 109.023$, which is highly significant ($p < 0.0001$). The adjusted residuals for cormorants, murres, geese, and "other" were all significant at the 0.05 level (Supplementary Table 1). Between the Middle and Late periods, the $X^2 = 75.539$ ($p < 0.0001$), with the adjusted residuals for murres, geese, and "other" all significant at the 0.05 level. The Early versus Late period comparison resulted in a $X^2 = 56.77$ ($p < 0.0001$), with cormorants, geese, and "other" contributing most to the X^2, and significant at the 0.05 level. We infer that the proportion of ducks was the most stable of the top four bird groups over time at Rice Ridge.

As shown in Table 3, many of the taxa identified in the Rice Ridge assemblage can be found in the Kodiak area during multiple seasons, including cormorants, murres, some ducks and geese, gulls, loons, eagles, ptarmigans, and raven. Clearly, people on Kodiak could obtain different species of birds at different times of the year. Kodiak provides suitable conditions for summer breeding for

Table 3. Seasonality and abundance of birds identified archaeologically at Rice Ridge (49-KOD-363), following MacIntosh (2009).

		Abundant, Common, Uncommon, Rare				
Scientific Name	**Common Name**	**Spring**	**Summer**	**Fall**	**Winter**	**Nesting**
Cygnus columbianus	Tundra swan	U	U	U	R	X
Anser albifrons	White-fronted goose	U	*	R	—	—
Clangula hyemalis	Long-tailed duck	A	R	A	A	—
Somateria spectabilis	King eider	C	R	U	C	—
Somateria mollissima	Common eider	U	U	U	U	X
Polysticta stelleri	Steller's eider	C	*	U	C	—
Melanitta fusca	White-winged Scoter	A	C	A	A	—
Histrionicus histrionicus	Harlequin duck	C	C	C	C	X
Aythya collaris	Ring-necked duck	R	*	R	R	—
Lagopus cf. *lagopus*	Willow ptarmigan	C	C	C	C	X
Podiceps cf. *auritus*	Horned grebe	C	R	C	C	—
Gavia immer	Common loon	C	C	C	C	X
Fulmarus glacialis	Northern fulmar	A	A	A	C	—
Phalacrocorax sp.	Cormorant[1]	C	C	C	C	X
Uria sp.	Murre[2]	C	C	A	A	X
Cerorhinca monocerata	Rhinoceros auklet	R	U	R	R	X
Fratercula cirrhata[3]	Tufted puffin	A	A	A	R	X
Fratercula corniculata	Horned puffin	C	C	C	R	X
Ptychoramphus aleuticus	Cassin's auklet	R	U	U	*	—
Aethia psittacula	Parakeet auklet	R	R	R	*	X
Aethia cristatella	Crested auklet	*	*	C	C	—
Brachyramphus brevirostris	Kittlitz's murrelet	R	U	R	R	X
Cepphus columba	Pigeon guillemot	C	C	C	C	X
Larus sp.	Gull[4]	A	A	A	A	X
Rissa sp.	Kittiwake[5]	A	A	A	U	X
Haliaeetus leucocephalus	Bald eagle	C	C	C	C	X
Aquila chrysaetos	Golden eagle	U	U	U	U	X[6]
Falco rusticolus	Gyrfalcon	R	R	R	R	X
Corvus corax	Raven	C	C	C	C	X

Notes to Table:
Spring—March–May
Summer—June–August
Fall—September–November
Winter—December–February

A—Abundant: Species is very numerous in all proper habitat; the region regularly hosts great numbers of the species; sighting likelihood excellent.
C—Common: Species occurs regularly in most proper habitat; sighting likelihood good.
U—Uncommon: Species usually present in relatively small numbers, or higher numbers unevenly distributed; sighting likelihood fair.
R—Rare: Species occurs regularly in the region but in very small numbers; sighting likelihood fair to poor.
*—Species has been recorded no more than a few times in a season, usually occurs singly; sighting likelihood very poor.

(Continued)

Table 3. *(Continued)*

[1] Cormorant—abundance figures for pelagic cormorant (*P. pelagicus*), the most abundant cormorant on Kodiak.

[2] Murre—abundance figures for common murre (*U. aalge*), estimated to be 30x more abundant than thick-billed murre on Kodiak (Forsell and Gould 1981:19).

[3] Archaeological puffins were identified only to genus, but seasonality information is provided for both species present on Kodiak.

[4] Gull—abundance figures for glaucous-winged gull (*L. glaucescens*), the most abundant gull on Kodiak.

[5] Kittiwake—abundance figures for black-legged kittiwake (*R. tridactyla*), the most abundant kittiwake on Kodiak.

[6] A golden eagle nest on Kodiak was documented by Berns (1979), although this appears to have been a rare occurrence.

many species when an estimated 2.3 million birds inhabit Kodiak Archipelago ecosystems (Forsell and Gould 1981:26). However, in winter, Kodiak's complex network of bays and fjords provides prime habitat for an estimated 1.5 million birds that migrate further north and west to breed (Forsell and Gould 1981:26; U.S. Department of Commerce 1997). Due to its geographic position and protected waterways, Kodiak is a refuge, exhibiting the greatest diversity of wintering birds in Alaska (MacIntosh 2009:3). We employ MacIntosh (2009) to structure our discussion of site seasonality (Table 3), even though bird availability and abundances do not always conform easily to his typology of seasons, in which spring is defined as March, April, and May, summer is June, July, and August; fall is September, October, and November; and winter is December, January, and February. In the taxonomic accounts that follow this section, we draw from a wide variety of sources to provide more specific seasonality information.

In the accounts of the four most abundant groups of birds, we establish our identification protocols first and then incorporate information from local ecology, traditional ecological knowledge, and ethnographic and historical information to understand the larger trends over time in how Rice Ridge residents used birds during the Ocean Bay period. Then the taxa that occur in smaller numbers ($\leq$3% of the NISP) are considered in less detail. In a later section, we examine the faunal remains by stratum, comprised alternately (for the most part) of "red ochre floors" and "middens." After that, we combine the results of the bird analysis with a reevaluation of the mammal and fish remains to see whether individual site strata represent deposits that correspond to more limited seasonal use. Recall that the samples we selected for bird analysis were the same ones Kopperl (2003) analyzed for mammals and fish. A holistic analysis of all faunal classes should more accurately gauge whether season of use can be specified. Finally, we compare the Rice Ridge bird remains to those from Mink Island (Casperson 2009, 2012), the only other site in the region where as large a sample and as comprehensive an analysis of bird bones has been conducted.

Cormorants

Archaeological cormorants were identified to the genus *Phalacrocorax* only because the University of Oregon Department of Anthropology comparative collection contains pelagic and Brandt's cormorants (*P. pelagicus*, *P. penicillatus*) but not double-crested or red-faced (*P. auritus*, *P. urile*) (note that Cresser et al. 2020 now place pelagic, Brandt's, and red-faced cormorants in the genus *Urile*, and double-crested is now within the genus *Nannopterum*). Cormorants made up 36.6% of the Early subassemblage (Fig. 4) and are the birds on which Early Period residents of Rice Ridge were most heavily focused. Although the archaeological cormorants were not identified to species, pelagic, red-faced, and double-crested are the most likely species present in the assemblage. Today, pelagic cormorants are the most abundant of the three cormorant species that regularly breed in the Kodiak Archipelago, and red-faced cormorants are about one-third as abundant as pelagic (Corcoran 2016:48–49). The closest sizeable pelagic cormorant colony is located on Inner Long Island (within 17 km of Rice Ridge), but a red-faced cormorant colony is on Queer Island (within 7 km) (Corcoran 2013:10). Cormorant species do not segregate themselves, however, since pelagic and red-faced cormorants and pelagic and double-crested cormorants can be found perching on the same rocky cliffs (Corcoran 2018:4, 6). Double-crested cormorants are significantly less abundant than the other two species (Corcoran 2016; Forsell and Gould 1981), and today they breed on Afognak Island, considerably more distant from Rice Ridge than the pelagic or red-faced cormorant breeding areas.

Historically, cormorants were prized for their iridescent feathered skins. Under changing light, their feathered throat skins shift in color from black to green to purple. In Hrdlička's (1944:39) monograph, *Anthropology of Kodiak Island*, he quoted Holmberg (1856:364–365):

> Of all the bird parkas the ones that were constructed from the throats of the Phalacrocorax were the costliest and most wanted, and for this reason they were worn by the smart set. To prepare for such a parka more than 150 birds had to

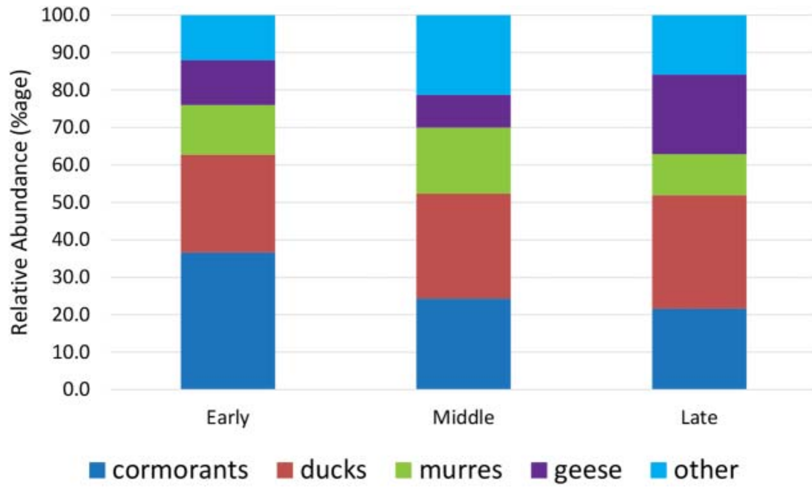

Figure 4. Relative proportions of main bird taxa from Rice Ridge by time period.

> be killed. The feathers were worn on the outside, and also embellished by the hairs of the reindeer, strips of the ermine or sea otter furs, as well as with the feathers of an eagle. With other parkas again, the feathers were turned to the inside of the body in nice weather, and the outer side was decorated with red stripes, figures, etc., all in painted fashion and from the front as well as from the back laid over with several pieces of the Phalocrocorax [sic] throats; should it rain then the entire dress was turned with the feathers to the outside so that the water might run down and over the feathers.

Hrdlička (1944:39–40), continued in this vein by quoting Petroff (1884:139–140), who described a bit more about processing cormorants:

> After the birds had been skinned the women removed the fatty particles by sucking, and then smeared them thickly with putrefied fish-roe and let them remain in this shape for some time. After a few days they were cleansed and kneaded with hands and feet until dry. The skins thus prepared were sewed together with needles manufactured from the bones of small birds, and thread prepared by a very tedious process from the dried sinews of the whale. The most valuable of all the bird-skin parkas were those prepared altogether of the necks of the cormorant, worn only by the young women, and a single garment required the necks of from 150 to 200 birds.

It seems possible that Petroff was drawing from Father Gideon (writing in 1804–1807), who wrote that Koniag women worked bird skins by "biting them with teeth and sucking out the fat" (Black 1977:100). Lydia Black's (1977) translations of the writings of two Russian Orthodox churchmen who lived on Kodiak, Bolotov (1794–1799) and Gideon (1804–1807), provide invaluable information about Alutiiq life at the time of Russian contact and colonization. Two types of birdskin parkas were mentioned, those made of "Toporki," which Black translated as puffins, and those made of "Uriles," a bird she was unable to identify (Black 1977:107), but which Davydov (1977:229) indicates is cormorant. Gideon stated that annually, the Alutiiq hunted enough uriles (cormorants) to make 200 parkas (Black 1977:102). Since Pratt (1990:78) found that 15–18 cormorant skins were required to make a parka, this amounted to the killing of between 3,000 and 3,600 cormorants annually during the Russian period. A Yup'ik consultant also described chewing cormorant skins to remove the fat, drying and softening them, and then cutting off the necks to make them rectangular (Fienup-Riordan 2007:208).

Following the quoted passage above, Petroff continued by repeating some of Holmberg's text, noting that parkas could be worn feather-side out (in wet weather) and skin-side out (in dry weather). He reiterated that the skin side of a parka was ornamented with red figures and lines. The use of red pigment to decorate cormorant skins may be related archaeologically to the red ochre-stained bones found in the assemblage and the "red ochre floors" described by Hausler-Knecht. Perhaps red ochre was used as flour is today to help remove moisture when softening bird skins (Fienup-Riordan 2007:210). Red ochre and grease together were used to waterproof skins (Paterek 1994:449).

It seems likely that Early Period residents of Rice Ridge skinned cormorants and used the skins to make clothing. Although the mid-19th-century sources mention that cormorant parkas were worn by the "smart set" (Holmberg) or "only young women" (Petroff), during the earlier Russian period, most all Alutiit wore bird-skin parkas because the company disallowed them from wearing clothing of sea otters and other mammals (Black 1977:101). Gideon wrote that "in the old days," bird-skin parkas were worn only by the poor (Black 1977:101). In the past, in addition to parkas, bird skins were made into blankets, rugs, mats, and bags (Vaughan 1992:29).

More recently, Yup'ik consultants mentioned that the tail and wing feathers of pelagic cormorants made beautiful fletching for spears and arrows used to hunt seals, and white cormorant feathers are still used in making dance fans (Fienup-Riordan 2007:172, 210, 335). The Aleut used various cormorant feathers in different ceremonial contexts, their wings as combs, sterna to make spoons, and beaks and bones to make other tools (Funk 2018:150, 152, 156).

Did Alutiiq ancestors consume cormorants as food? The ethnographic records from southcentral and western Alaska differ on the palatability of cormorants. Nunivak Islanders dried and preserved the wings, breasts, and legs of colonial nesting birds for food according to one of Pratt's (1990:82) consultants, although specific birds are not mentioned. Aleuts did eat cormorants but considered them "foul-tasting emergency food only" (Funk 2018:151). Aleuts viewed cormorants as springtime starvation food, judged their eggs "acceptable," and the hunting of cormorants "was associated with stories of antisocial behaviors like rape and incest" (Funk 2018:156). Davydov (1977:230) wrote that on Kodiak, urile eggs tasted "very unpleasant," but whether this is his personal assessment or that of the Alutiit is unclear. Whether or not Yupi'it ate cormorants is unclear. Fienup-Riordan (2007:200) noted that the Yup'ik word, "*yaqulepiaq*, means [eatable birds, lit. 'real birds'] for food." Some birds may not have been well-regarded as food, but during the lean seasons (late winter–early spring), Yupi'it people ate a variety of foods that might not have been preferred (Fienup-Riordan 2007:117–122). Early Period residents of Rice Ridge likely consumed cormorants. Based on their high abundance in this subassemblage, these birds provided critical food and material resources.

Early Period harvest methods may have included cliff-hanging, hand-netting, snaring, clubbing, and taking with a noose or by hand (Corbett 2016:102–103). As Pratt (1990:76 explained, "cliff-hanging is the practice of descending and ascending cliff faces by means of skin ropes in association with using large throw-nets to capture nesting seabirds." This was usually done at colonies, but both Queer and Inner Long Island seem reasonably distant from Rice Ridge (7 km and 17 km away, respectively). However, cormorants roost on land (Forsell and Gould 1981:11), so perhaps they were taken at night, as Davydov (1977:229) indicated. Flocks as large as 125 cormorants have been observed during winter in Kodiak waters (Forsell and Gould 1981:11), and Gideon wrote that cormorants were hunted in the spring (Black 1977:102). The lack of identifiable juvenile cormorant bones (in any of the three subassemblages) suggests winter to spring harvest. Cormorants were certainly processed at Rice Ridge in significant numbers.

Over time, the relative proportion of cormorants decreased from 36.6% in the Early Period to 24% during the Middle Period and 22% during the Late Period (Table 2, Fig. 4). These Middle and Late period proportions are still substantial, suggesting that cormorants continued to be vitally important to Rice Ridge residents. Since the Middle Period take of cormorants is smaller relative to that of other birds than it was during the Early Period, perhaps Early Period site residents heavily harvested cormorant colonies (especially if some were located closer to Rice Ridge during Ocean Bay times), and as a result, fewer birds were locally available to harvest during later periods. Alternatively, perhaps by the Middle and Late periods, Rice Ridge residents had diversified their use of birds to prevent negative impacts to resident breeders (Zweifelhofer et al. 2008:3, 56), such as cormorants.

Murres

Archaeological murres were identified to the genus *Uria* because while the UO comparative collection contains a good group of common murres (*Uria aalge*), it lacks the thick-billed murre (*U. lomvia*). Murres make up 13% of the Early subassemblage, 18% of the Middle subassemblage, and 11% of the Late subassemblage from Rice Ridge (Fig. 4). Based on winter surveys in Kodiak's bays, Forsell and Gould (1981:19) observed common and thick-billed murres in a ratio of 30:1. These authors characterized Kodiak as a major nursery and wintering ground for murres, which they assessed as the most abundant and ubiquitous of all birds in the winter (Forsell and Gould 1981:19), consistent with what Zweifelhofer et al. (2008:83) found 25 years later. Over a million murres once wintered in Kodiak waters (Forsell and Gould 1981:20). Murres apparently take refuge on the east side of Kodiak during winter storms, where Forsell and Gould observed an aggregation of 1,300 murres along the south side of Ugak Island, about 11 km from the Rice Ridge site. During spring to summer, the murres that winter in Kodiak waters breed on rocky islands or cliff ledges scattered across the greater Gulf of Alaska or Bering Sea coast (Forsell and Gould 1981:20). Corcoran's (2013, 2016:61) surveys indicate that other murres are present in the summer on Kodiak, but there are "few known breeding colonies." Today, the murre nesting areas closest to Rice Ridge are the rocks northeast of Cape Chiniak, located about 12 km from the site (Robin Corcoran, personal communication 2021). Murres are deep-diving birds, and today, they are frequently part of the bycatch of crab fishers (Corcoran 2016:61; Manly 2007). Murre population size changes with sea-surface temperature, and oscillating patterns of abundance characterize many murre colonies (Corcoran 2016:61).

At their colonies, murres could be taken in nets mounted on the end of long poles while standing on cliffs to sweep up into the path of landing birds (Vaughan 1992:31). Today, murres are present in winter and summer, although Forsell and Gould (1981:19-20) indicate their abundance is far greater in winter. Their consistent presence throughout all Rice Ridge strata strongly suggests occupation of the site during fall and winter, when murres come closer to shore during storms. On Nunivak Island, Andrew Noatak described how people used murre meat:

> [A]though they had hardly any meat on wings, legs or breasts they dried them, and they gathered a whole bunch. They also used the murres' legs. They did not throw away anything (Pratt 1990:82).

Alutiiq ancestors probably ate murres and used their skins to make parkas.

Yupi'it also made parkas out of murre skins. Fienup-Riordan (2007:205) described one such example made of 35 whole murre skins and seven split skins:

> A skin consists of the white breast, dark sides, and part of the dark neck, and is split down the back. The body and sleeves are made with breast skins (which are thicker), sewn vertically, while back skins and small section of breast skin made up the hood and bottom. All seams are on the exterior and sewn with a running stitch. Thick bird-skin parkas were ideal winter wear but were also used during cold weather in the summer.

Whether this parka, now at the Burke Museum (which appeared to be in pristine condition), was made for trade purposes or commissioned as an art piece is unclear.

Rice Ridge residents probably hunted murres in winter, either offshore from kayaks using spears or inshore with nets and snares, rather than trapping or snaring them at colonies in the spring and summer. Murre hunting was most intensive during the Middle Period compared to that of the Early and Late periods, and perhaps during the Middle Period, a group of Rice Ridge hunters encountered a winter murre aggregation nearshore. Such a "windfall" might account for the bounty of murres during the Middle Period. Overall, murres were the third most common taxon in the assemblage. Hunting during winter would have had a less negative impact on murre populations than hunting at colonies, especially since birds wintering on Kodiak reproduce at many distant locations across the Bering Sea and the Gulf of Alaska. Although we do not know what aboriginal practices may have promoted conservation prior to the Russian period, the scale of Ocean Bay hunting does not appear to have negatively affected murres, as they were still available during the Late Period after heavy use during the Middle Period.

Ducks

Duck identifications are based on bone morphology, some to species, some to genus, some to tribes, or some to more general categories such as large ducks and small ducks. Woolfenden (1961) was a primary source used in identification; the most diagnostic elements include humeri, carpometacarpi, sterna, coracoids, scapulae, furcula, femora, tibiotarsi, tarsometatarsi, and synsacra (pelvises). Woolfenden (1961) did not find ulnae, radii, and fibulae to be very useful, so our identifications of these elements will be more generic than of the other ten elements. If a bone could not be assigned to species, genus, or tribe, it was classified as a large or small duck. Large ducks include those at least the size of the smallest white-winged scoter in our comparative collection (about 1,300 g), and small ducks include those smaller than this scoter. Large ducks include most eiders and the common merganser. The small ducks include representatives of various tribes: Anatini, Aythyini, and Mergini (including Steller's eider). Table 4 presents the ducks recorded in the Kodiak National Wildlife Refuge, specifies those that are common or abundant (during at least one season), and shows how we grouped ducks into the "large" and "small" categories to facilitate the identification of archaeological specimens.

The most abundant species in the Rice Ridge assemblage is common eider, making up 26% of the ducks. We note that common eiders are particularly abundant during the Middle Period, making up 31% of ducks versus 21% in the Early Period and 22% in the Late Period. The next most abundant ducks are white-winged scoter at 5% and king eider at ~3%.

On Kodiak today, some common eiders are year-round residents but are evaluated as "uncommon" during all seasons (MacIntosh 2009; Waltho and Coulson 2015:68). A few common eider nests were found on several small islands in Chiniak Bay (Nysewander and Hoberg 1978:15) in 1977, and biologist Robin Corcoran found one in 2020, but they

Table 4. Ducks commonly available in the Kodiak Archipelago and categories used in archaeological identification.

	Common	**Nesting**	**Large Duck**	**Small Duck**
Wood duck	—	—	—	—
Gadwall	**X**	**X**	—	Gadwall
Eurasian wigeon	—	—	—	—
American wigeon	**X**	**X**	—	American wigeon
Mallard	**X**	**X**	—	Mallard
Eastern spot-billed duck	—	—	—	—
Blue-winged teal	—	—	—	—
Cinnamon teal	—	—	—	—
Northern shoveler	**X**	—	—	Northern shoveler
Northern pintail	**X**	**X**	—	Northern pintail
Green-winged teal	**X**	**X**	—	Green-winged Teal
Canvasback	—	—	—	—
Redhead	—	—	—	—
Ring-necked duck*	**X**	—	—	Ring-necked duck
Tufted duck	—	—	—	—
Greater Scaup	**X**	**X**	—	Greater scaup
Lesser scaup	—	**X**	—	—
Steller's eider	**X**	—	—	Steller's eider
Spectacled eider	—	—	—	—
King eider	**X**	—	King eider	—
Common eider*	**X**	**X**	Common eider	—
Harlequin duck	**X**	**X**	—	Harlequin duck
Surf scoter	**X**	—	—	Surf scoter
White-winged scoter	**X**	—	White-winged scoter	—
Black scoter	**X**	**X**	—	Black scoter
Long-tailed duck	**X**	—	—	Long-tailed duck
Bufflehead	**X**	—	—	Bufflehead
Common goldeneye	—	—	—	—
Barrow's goldeneye	**X**	**X**	—	Barrow's goldeneye
Smew	—	—	—	—
Hooded merganser	—	—	—	—
Common merganser	**X**	**X**	Common merganser	—
Red-breasted merganser	**X**	**X**	—	Red-breasted merganser

Note: Nesting and abundance from MacIntosh (2009) and weights from Sibley (2003). Even though "not common" because they were identified archaeologically, ring-necked and common eider are included; 1,300 g is the cut-off between large and small ducks.

are rare on Kodiak (Wolfe and Paige 1995:87). As Corcoran (personal communication 2021) has written, "Kodiak just isn't a safe place to be a ground-nesting duck" because of predation by bears, foxes, and river otters, even on offshore islands. The high relative abundance of common eiders in the archaeological assemblage is at least partly due to their being the largest duck in North America (Sibley 2003:86). Hence, it is somewhat easier to identify than smaller species. King and Steller's eiders are characterized as winter visitors and common in winter and early spring (MacIntosh 2009; Sibley 2003:86–87). In the 20th century on Kodiak, the king eider was as much as 20 times more abundant than the common eider (12,000 versus 400–500) (Forsell and Gould 1981:15). In Chiniak Bay, specifically, the king eider was 11 times more abundant than the common eider (Forsell and Gould 1981:39). King eiders have been specifically identified in the assemblage, but other king eider bones not identified to species have probably been classified as *Somateria* sp., Mergini, or large duck.

Both the common and king eider numbers fluctuate from year to year; Kodiak is at the southeast edge of their wintering range, and conditions in the Bering Sea probably force this variation (Robin Corcoran, personal communication 2021; Forsell and Gould 1981:15). Steller's eider has also been identified at Rice Ridge. It breeds in northern Alaska and Russia and winters in the eastern Aleutian Islands eastward to lower Cook Inlet. Forsell and Gould (1981:14, 39) found Steller's eider to have been the most widely distributed eider on Kodiak; it was 1.7 times more abundant in Chiniak Bay than common eider. Today, eiders are sought by trophy duck hunters for their colorful plumage, and their feathers must undoubtedly have been valued by Alutiiq ancestors in the past. The Hooper Bay Yupi'it preferred the "soft blue-gray colours" of the king eider for making their bird-skin parkas (Vaughan 1992:29, quoting Brandt 1943). Common eiders and king eiders are just some of the species Yupi'it regularly used to make bird-skin parkas (Fienup-Riordan 2007:204). According to a consultant, Steller's eiders were too thin-skinned to make into parkas (Fienup-Riordan 2007:204).

The discrepancy between the high relative abundance of common eiders in the archaeological assemblage versus the low relative abundance in Kodiak's environment today could be because of the following reasons (singly or in combination):

1) because of their large size, archaeological common eiders are easier to identify compared to other ducks;

2) common eiders were relatively more abundant in Ocean Bay times than they are today, especially in comparison to king and Steller's eiders;

3) common eiders have been differentially and negatively affected by modern environmental conditions on Kodiak or elsewhere within their range (e.g., over-hunting [Goudie et al. 2020], climate change, or some other factor).

With regard to Steller's eiders, despite occurring in more significant numbers today than both king and common eiders, they are considered "vulnerable" by the International Union for the Conservation of Nature (IUCN). In contrast, common eiders are "near-threatened," and king eiders are of "least concern" (BirdLife 2012, 2018a, 2018b). This differential characterization exists because the global populations of king eiders are six times that of Steller's eiders, and the global population of common eiders is 22 times that of Steller's eiders. The worldwide population of Steller's eiders declined as much as 50% in the past 30 years, and in 1997, the Alaska breeding population was listed as threatened under the Endangered Species Act (Bowman et al. 2015:1; USFWS 2010). Recent surveys on Kodiak have shown declines in Steller's eiders over the last 20 years (Corcoran et al. 2010; Larned and Zwiefelhofer 2001).

White-winged scoters make up 5% of the ducks identified in the Rice Ridge assemblage. Forsell and Gould (1981:15–16) found white-winged scoters to have been the most abundant scoters around Kodiak, with an estimated 35,000 nearshore, and along the outer coast during the winter of 1979–1980. White-winged scoters are winter migrants who do not nest in the Kodiak Archipelago (Zweifelhofer et al. 2008:3). They are rare from late May through the end of July, although failed breeders (from interior Alaska) start to migrate in August (Robin Corcoran, personal communication 2021). Rice Ridge residents may have pursued white-winged scoters when they move inshore during winter to avoid stormy conditions; in good weather, they prefer to feed in offshore shoals (Zweifelhofer et al. 2008:47). Along with specimens identified to genus (*Melanitta* sp.), scoters make up 10% of the ducks. Unlike Forsell and Gould (1981), Zweifelhofer et al. (2008:38) found black scoters to be the most abundant scoter on Kodiak in their winter surveys. Although some black scoters breed locally, most are winter migrants. Local subsistence hunters have shown a preference for black scoters (Zweifelhofer et al. 2008:47), while the surf scoter appears less abundant, with its seasonal occurrence similar to that of white-winged scoters. Like the eiders, scoters were probably taken by Rice Ridge residents during winter, when they were abundant and foraging nearshore. Like common eiders, scoters are somewhat more abundant in the Middle Period (11%) compared to the Early and Late periods (8% for both).

In the Lime Village area of Alaska, scoters were preferred over many other ducks because they "consistently have a thicker layer of fat" than other ducks except the bufflehead (Russell and West 2003:81; eiders are not locally available to Lime Villagers). Alaska Natives highly valued/value ducks as food, and like the king and common eiders, white-winged scoters were regularly used by Yupi'it to make birdskin parkas (Fienup-Riordan 2007:204). Both common eiders and white-winged scoters are large ducks, and if we lump together large ducks, large eiders, and scoters together, they comprise 58% of the Rice Ridge ducks. Small ducks identified to species include long-tailed, harlequin, and ring-necked; only the harlequin duck nests on Kodiak.

All considered, the bulk of duck hunting by Rice Ridge residents probably occurred in winter, perhaps from late fall through early spring. As Dick (1977:506) described, "[M]ost ducks leave before the puffins arrive in April–May." Yet, some of the most abundant duck species observed by Forsell and Gould (1981) in the winter are not species identified from Rice Ridge: mallards, pintails, green-winged teals, greater scaups, Barrow's goldeneyes, and buffleheads. These same taxa, along with harlequin ducks, were the most frequently taken by Kodiak City subsistence hunters in 1993 (Paige and Wolfe 1997: Appendix Table 14). Forsell and Gould (1981:14) considered long-tailed ducks the most abundant waterfowl in Kodiak Island bays, even though we only identified one archaeological specimen as this species. These discrepancies are hard to interpret without more knowledge about how climate and other environmental changes over the last several thousand years may have affected duck populations and their reproductive and migratory behaviors.

An Alutiiq hunting method specifically designed for ducks was to stretch a low weighted net across a narrow strait that would entangle low-flying ducks at sunset or sunrise (Davydov 1977:228). Bows and arrows and bolas were also used to bring down birds in flight (Vaughan 1992:30). Multipronged bird darts were thrown with atlatls. Since the most common ducks found in the Rice Ridge assemblage nest and molt in other parts of Alaska, we assume Alutiiq did not use drives or traps in the same way Yupi'it did (Fienup-Riordan 2007; Hensel and Morrow 1998).

Alaska Natives have traditionally eaten many parts of waterfowl, including meat, fat, bone marrow, organs, feet, gizzard, and parts of the head (Russell and West 2003:27). The amount of oil or marrow contained in bones differed by species and time of year; fall ducks have more leg bone marrow than spring ducks (Russell and West 2003:28). Russell and West learned that Lime Villagers preferred waterfowl with the highest fat content; at this location in interior Alaska, people preferred scoters, buffleheads, goldeneyes, and harlequin ducks. Regarding the harlequin ducks on Kodiak, Davydov (1977:228) wrote that "they are so fat they can only rise out of the water with great effort."

To cook waterfowl, Lime Villagers sometimes singed the birds to remove their feathers and then washed, butchered, and cooked them (Russell and West 2003:28). At hunting camps, people roasted gutted ducks and geese slowly on a spit over an open fire. They could also be pit-baked. Alaska Natives also smoked gutted ducks and geese in the smokehouse for several days to a week, "both to flavor and to preserve them" (Russell and West 2003:28).

Russell and West (2003:29) explained that feathered skin clothing was made from the "wingless bodies of the larger birds from which the tail and other large feathers have been removed." When Alaska Natives made clothing from other animal skins (e.g., bears, small mammals), they often used soft downy feathers of ducks and geese as filling for warmth (Russell and West 2003:29; Stanek 1985:82).

As presented in the statistical analysis above, the overall proportion of ducks across the three time periods was not significantly different: 26% during the Early Period, 28% during the Middle Period, and 30% in the Late Period. Ducks did not contribute significantly to the X^2, and they were the most stable of the top bird groups over time. With a greater proportion of the ducks identified to species, however, we might have found more detailed patterns of change through time.

Geese

The use of geese by Rice Ridge residents raises more questions than answers. Geese make up 12% of the Early Period subassemblage but decrease to 8.7% in the Middle Period. In the Late Period, geese comprise 21.2% of the Late Period subassemblage. These differences are statistically significant, as presented earlier. Except for the minor occurrences of swan in the Middle and Late periods, geese are the largest and meatiest of Rice Ridge birds. Based on optimal foraging theory,[2] we might expect that geese would have been intensively hunted during the earliest period of site occupation, even to the point of being over-hunted. Perhaps over-hunting of available geese led to the slight decline seen during the Middle Period. Yet, the high relative abundance of geese in the Late Period goes against expectations based on optimal foraging theory. This pattern of changing abundances, however, is hard to interpret without knowing which geese species are present in the assemblage, whether this varies over time, and how Ocean Bay climate might have affected geese migratory and reproductive behaviors.

Although Canada goose populations nest on Kodiak today, most are *Branta canadensis fulva*, introduced by the Alaska Department of Fish and Game in 1986 (Robin Corcoran, personal communication 2021), so contemporary patterns of their abundance cannot be projected onto the past. The cackling Canada goose is uncommon in spring and rare in fall and winter, brant is common in spring but rare in summer, the snow goose is rarely seen any time of year, and the white-fronted goose is uncommon in spring and rare in fall. The most abundant goose species today is the emperor goose, common from October to April when "the other geese species just migrate through" (Robin Corcoran, personal communication 2021). In winter, emperor geese prefer rocky intertidal habitats on Kodiak (Forsell and Gould 1981:11), and in summer, they nest in the Yukon-Kuskokwim Delta region.

As discussed earlier, geese are difficult to differentiate archaeologically based on morphology. As shown in Table 2, brant and white-fronted goose have been identified in the assemblage, but 97% of the goose bones have been identified only to subfamily Anserini. Of the cranial elements, several appeared to be from emperor geese, but because of their fragmentary condition, this attribution remains uncertain. On Kodiak today, many hunters are highly interested in the recovery of emperor geese populations (e.g., Haugen 2018) that are still considered "near threatened," having declined as much as 50% since the 1960s (Avibase 2020).

We conducted a preliminary stable isotope study aimed at distinguishing emperor geese from other geese, based on previous studies showing that most geese have $\delta^{13}C$ and $\delta^{15}N$ values corresponding to primary consumers in terrestrial food webs, while emperor geese have higher $\delta^{13}C$ and $\delta^{15}N$ as marine consumers (Gorlova et al. 2015:117; Krylovich et al. 2019:9). Finding that emperor goose was the predominant goose species across the occupations at Rice Ridge would be significant, as we might infer long-term continuity in their reproductive and migratory behavior over time. If geese other than emperors dominate the assemblage, we might have evidence of significantly different habitat conditions for the relevant species, especially during the Late Period when many geese were taken.

Our results show that bone collagen is well preserved in archaeological specimens (atomic C:N ratios range from 2.9 to 3.1) and is distinct isotopically when comparing cormorants (mean $\delta^{13}C = -12.6 \pm 0.2‰$, mean $\delta^{15}N = 18.0 \pm 0.5‰$, mean $\Delta_{carb\text{-}coll} = 4.8 \pm 0.7‰$) and geese (mean $\delta^{13}C = -19.6 \pm 1.2‰$, mean $\delta^{15}N = 9.1 \pm 0.7‰$, mean $\Delta_{carb\text{-}coll} = 8.3 \pm 1.2‰$). These results, shown in Fig. 5, indicate significant dietary differences between cormorants

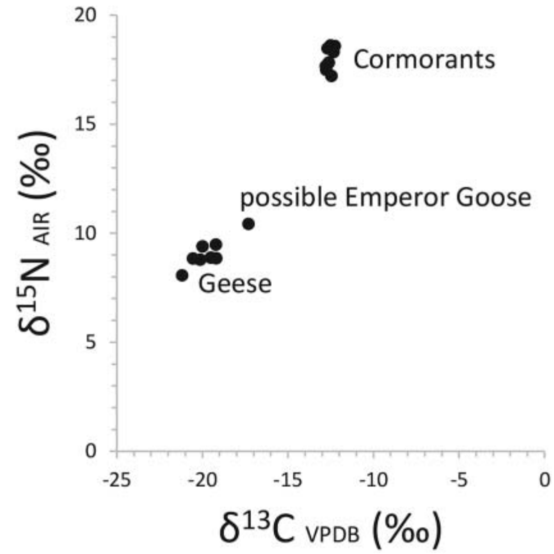

Figure 5. Stable carbon and nitrogen isotopic composition of cormorant and geese bones from Rice Ridge.

and geese at Rice Ridge, similar to the difference between present-day terrestrial and marine birds in the region (Gorlova et al. 2015). Intriguingly, the goose specimen (catalog #KOD363/2012-106/6/19.02.1) with the highest $\delta^{13}C$ (–17.3‰) and $\delta^{15}N$ (10.4‰) also shows anomalously low $\Delta_{carb\text{-}coll}$ (5.4‰) compared to the other geese and similar to $\Delta_{carb\text{-}coll}$ of cormorants. The combination of relatively high $\delta^{13}C$, high $\delta^{15}N$, and low $\Delta_{carb\text{-}coll}$ is consistent with the possibility that this goose consumed more marine and/or animal foods, although in this case, whether we detect diet variation among one or multiple species of geese is unclear. If the specimen is an emperor goose, these results would indicate that emperor geese and cormorants rely on isotopically distinct diets. Alternatively, this individual could be a non-emperor goose consuming terrestrial foods including lipid, protein, or carbohydrate sources that alter carbonate to collagen spacing (Codron et al. 2018; O'Connell and Hedges 2017). The absence of unambiguous emperor geese at Rice Ridge may be an artifact of our relatively small sample size or could be an indication that emperor geese are indeed rare. Additional study is needed to assess better the possibility and frequency of marine feeding among Rice Ridge geese. More generally, our results are significant in demonstrating the potential for distinguishing marine- and terrestrial-feeding bird remains using a multivariate approach ($\delta^{13}C$, $\delta^{15}N$, and $\Delta_{carb\text{-}coll}$), which may recover more subtle differences between groups than is possible when using only $\delta^{13}C$ and $\delta^{15}N$. Further research is needed to evaluate the potential of this approach for identification of archaeological remains in the Arctic and elsewhere.

In the absence of nesting and molting on Kodiak, we can infer that hunting methods for geese were similar to those already described for ducks. Davydov (1977:227) wrote that on Kodiak, geese were snared. For making parkas, Yupi'it preferred emperor geese over the more thin-skinned Canada geese and white-fronted geese whose skins tear easily (Fienup-Riordan 2007:204). Hooper Bay Yupi'it also valued emperor geese skins for their "soft blue-gray colours" (Vaughan 1992:29, quoting Brandt 1943). Skins of newly molted birds were preferred, and male birds were favored for skin sewing. As Fienup-Riordan (2007:208) explained, "male birds were preferred for parka-making as females had stretched stomachs with no down feathers from sitting on their nests." Goose-hunting for the highest-quality skins might start in late fall or winter when the birds arrived on Kodiak; geese could be taken prior to their departure for nesting in the spring. Goose meat and eggs continue to be highly relished in Alaska Native communities. Goose bones have been used in needle manufacture (Gelvin-Reymiller and Reuther 2010) and may be present in the Rice Ridge artifact collection at the Alutiiq Museum.

Other Taxa

Overall, 17% of the Rice Ridge assemblage is made up of birds other than cormorants, murres, ducks, and geese.

Small Alcids

The "small-alcids" category includes all alcids other than murres, although hunting and processing methods may have been similar to those used when taking and using murres. Small alcids comprise 4% of the assemblage overall. Over half are crested auklet (54%), followed by pigeon guillemot, puffin, parakeet auklet, rhinoceros auklet, *Brachyramphus* murrelet, and Cassin's auklet. We were unable to identify puffins as either horned or tufted or murrelets as marbled or Kittlitz because of limitations in our comparative specimens.[3] Today, crested auklets ("sea quail") are "strictly winter visitors" (Forsell and Gould 1981:21). On Kodiak, crested auklets are at the eastern limit of their nonbreeding range and present mid-November through January, with peak numbers in December–January, although these vary year-to-year (Robin Corcoran, personal communication 2021; Forsell and Gould 1981:21). A concentration of crested auklet bones (NISP = 53) occurred in Stratum D, and a significant number in Stratum C (NISP = 25), dated to 5800–5700 cal. BP (Middle Period). This may represent opportunistic captures of these birds as they are known to aggregate after they move into the bays on eastern Kodiak by late November (Forsell and Gould 1981:21).

Pigeon guillemots are common throughout the year on Kodiak today, whereas horned and tufted puffins are common in all seasons except winter (MacIntosh 2009). All three taxa nest on Kodiak, and we expect that Alutiiq ancestors took them at their colonies. Today, researchers simply reach into burrows to take adults (Robin Corcoran, personal communication 2021), and Alutiiq ancestors may have done this as well. The birds were eaten, their skins sewn into clothing, and the bill sheaths or beaks of puffins and auklets were used to decorate garments (Vaughan 1992:30). Small numbers of pigeon guillemots have been recorded on colonies on Kekur, Svitlak, Middle, and Utesistoi islands (all within 3 km of Rice Ridge), with horned puffins also noted on Middle Island (Corcoran 2013:50, 57). Tufted puffins are found in larger numbers on these same four islands. Tufted puffins were the most abundant alcid that Corcoran (2013:29) counted during her colony surveys on Kodiak.

Gideon explained how Alutiiq boys and elderly men, who were not fit to hunt sea otters, were drafted to hunt birds for the Russian American Company (RAC) (Black 1977:101). They were sent in small groups to "small islands and rocks" (breeding colonies), and each was charged with hunting enough puffins to make seven parkas (Black 1977:101). The number of birds required for one parka was estimated to be 35 skins, which translated to each hunter killing 245 puffins. Gideon wrote,

> by the middle of July this hunt stops, as the birds, having raised their young, leave their nests. It is then that these laborers are permitted to hunt for themselves up to the middle of September (Black 1977:101).

This suggests that there were numerous puffin breeding colonies on Kodiak during the time of Gideon's stay from 1804 to 1807. The RAC clearly promoted summer hunting of the seabird colonies.

Father Gideon described how hunters captured puffins with snares at the top of the cliff or used ladders to access cliff sides (Black 1977:101). During the period of the hunt, men subsisted on bird meat while they dried their skins. The skins were surrendered to the RAC and later doled out to Alutiiq women who sewed parkas that were then given back to the RAC. Because the RAC forbid Alutiiq to make any parkas for themselves out of sea otter or fox skins, they wore bird-skin parkas (Black 1977:101). It was a brutal economic system that wreaked havoc with traditional Alutiiq family life (see Margaris et al. 2015), and it also resulted in the intensification of hunting birds and foxes in addition to sea otters. The relatively low abundance of puffins and pigeon guillemots in the Rice Ridge assemblage is somewhat surprising given that they currently nest in the vicinity. This suggests that summer pursuit of puffins and other small alcids at their colonies was not a significant site activity across the time periods when Rice Ridge was occupied.

The abundance of winter-migrant murres in the assemblage suggests winter occupation, and the crested auklets in the Middle Period strongly support winter occupation. Parakeet auklets, which are rare in spring, summer, and fall on Kodiak today and hardly ever seen in winter (MacIntosh 2009), along with the modest numbers of pigeon guillemots and puffins, could have been taken at their summer nesting sites. However, they also may have been obtained incidentally during other times of the year.

Loons

Loons comprise 3% of the Rice Ridge assemblage overall, with 93% identified as common loons. Loons are found on Kodiak year-round (MacIntosh 2009), although in small numbers, with the common loon predominating (Forsell and Gould 1981:9). The common loon has been classified as a winter migrant (Zweifelhofer et al. 2008:3), so the substantial number of loons present in the assemblage, with abundances comparable to some of the gregarious ducks, also support winter occupation. Loons were likely eaten, and their skins used to make parkas and other clothing (Fienup-Riordan 2007:200). Many Alaska Natives respect loons for their prophetic abilities and commemorate this in artworks (Fienup-Riordan 2007:213; Hill 2019).

Gulls (Laridae)

Gulls and kittiwakes comprise 3% of the Rice Ridge assemblage overall, but we did not identify their bones beyond the genera *Larus* and *Rissa*. The most common gulls on Kodiak today are glaucous-winged and mew gulls, both of which nest in the archipelago. Black-legged kittiwake is the most common kittiwake, which also nests on Kodiak. These birds are generally common or abundant during most seasons, although the kittiwake is uncommon in winter (MacIntosh 2009). Both glaucous-winged gulls and black-legged kittiwakes have substantial colonies on Kekur, Svitlak, Middle, and Utesistoi islands (Corcoran 2013:50, 57). Gull meat and eggs were probably eaten, and their bones and feathers used to make lures and hooks (Fienup-Riordan 2007:214; Russell and West 2003:129; Vaughan 1992:34).

Swans

Only two swan bones were identified in the Rice Ridge assemblage. On Kodiak today, tundra swans are uncommon from spring through fall and rare in winter (MacIntosh 2009). Trumpeter swans are rare in spring and fall when they migrate through. However, based on the utility of long swan bones, we expect that analysis of the artifact assemblage in the Alutiiq Museum collections might result in the identification of some artifacts made of swan bones. This might be a direction for future research.

Eagle and Raven

Only 30 bald eagle bones and ten raven bones were identified in the Rice Ridge assemblage, although both species are very common throughout the year and nest on Kodiak (MacIntosh 2009). One golden eagle bone was identified with the help of Trail (2017), and this species also nests on Kodiak (Berns 1979). Because Hausler-Knecht (n.d.b:6) noted a "fair number of eagle or raven talons," and we found only five of them, perhaps some were classified as artifacts and are curated at the Alutiiq Museum. Ravens and eagles play/played important social and symbolic roles in many Alaska Native cultures, but we suspect that they are underrepresented in the Rice Ridge bird assemblage reported here because of curatorial practices.

Albatross, Shearwater, and Northern Fulmar (Procelleriidae)

Albatrosses are represented by 11 bones found in the Early and Middle period subassemblages. Today, only the black-footed albatross is common in the offshore waters of the Kodiak Archipelago from March through November (Gould et al. 1982:14), but Laysan's and short-tailed albatross could be represented at Rice Ridge. Ancient DNA study of the albatross bones would result in species information that might be useful, not just to archaeologists but to biologists trying to better understand the demise of some albatross species over the years. The short-tailed albatross is still recovering from near extinction in the 1920s due to commercial overexploitation (USFWS 2017).

Shearwaters are represented by only three bones. Today, sooty and short-tailed shearwaters are abundant during mid-summer, common in early fall, and rare in winter (MacIntosh 2009). Flocks of thousands can be observed off Cape Chiniak in late summer (Robin Corcoran, personal communication 2021). These bones could also represent other shearwater species (pink-footed, flesh-footed, or Bullar's), and again, study of aDNA may be informative.

Northern fulmar is represented by only two bones, even though today, this species is far more abundant than the other procelleriids (Forsell and Gould 1981:10). Fulmars are abundant spring through fall and common in the winter (MacIntosh 2009). Interestingly, northern fulmars were the most abundant bird identified at Qik'rtangcuk, a Kachemak fish camp (Odell et al. 2019), although represented there by only 22 bones in a very small assemblage.

Albatrosses, shearwaters, and fulmars all frequent offshore habitats. Their small numbers in the Rice Ridge assemblage may indicate that they were taken incidentally when the Alutiiq were offshore hunting for marine mammals or traveling long distances. Their relatively small numbers do not suggest that people purposely targeted them as prey.

Ptarmigan

Ptarmigan are represented by 64 specimens in the Rice Ridge assemblage, most from the Middle Period. Ptarmigan were taken for their food value; their thin skins were not used to make clothing. Willow and rock ptarmigan are both common on Kodiak year-round (MacIntosh 2009). Ptarmigan are "highly prized for the vegetable matter usually found in its crop and stomach" (Vaughan 1992:26). They could be netted or snared on the ground or taken with bow and arrow and were typically roasted and boiled (Fienup-Riordan 2007:199; Russell and West 2003:108). The near absence of ptarmigan during the Early Period may be related to the heavy maritime focus of this time and because the habits of terrestrial species may take a while for people to observe. The relative abundance of ptarmigan in the Middle Period may reflect the importance of this bird during winter.

Gyrfalcon

Two gyrfalcon bones were identified in the Rice Ridge assemblage with the help of specialized publications (Bedetti and Pavia 2007; Li et al. 2014). This bird is rare on Kodiak, albeit present year-round, and its bones may represent birds killed opportunistically in both the Middle and Late periods. Since gyrfalcon prey upon ptarmigan, hares, and ground squirrels (Elphick et al. 2001:227; Keim 2010), perhaps gyrfalcons were killed as predator control. However, no hares or ground squirrels were identified by Kopperl (2003:167) in his analysis of the Rice Ridge mammals. The presence of gyrfalcons and ptarmigan in the Middle and Late subassemblages may also suggest a shift toward harvesting terrestrial resources. Gyrfalcon feathers were highly valued and traded by some Alaska Natives (Vaughan 1992:27).

Trace Occurrences

Grebes are represented by 15 bones. One small shorebird bone and ten sandpiper bones were also identified. MacIntosh (2009) indicates that horned grebes are common in all seasons except summer on Kodiak; Zweifelhofer et al. (2008:65) classified them as winter migrants when they forage in small flocks. The larger red-necked grebe is also a winter migrant when it is particularly common (Forsell and Gould 1981:9; Zweifelhofer et al. 2008:69). The number of grebe bones found in the Rice Ridge assemblage suggests they were not targeted regularly. In many Alaska Native societies, children first practice their hunting skills on small birds (Corbett 2016:98, 104; Davydov 1977:164; Fienup-Riordan 2007:197). Even small birds would be eaten to "fill in the gap between scarcity and abundance each spring" (Fienup-Riordan 2007:198). Lime Villagers did not harvest grebes for food but used their skins and feathers (Russell and West 2003:58).

Summary: Seasonality of Bird Use at Rice Ridge

In terms of the likelihood of Ocean Bay peoples taking certain birds at certain times of year, eider ducks and white-winged scoters (and probably other scoters) were most likely available in winter and early spring and are represented in all Rice Ridge strata. Murres and loons are also winter migrants whose abundance would be greatest in winter, and their remains are likewise found in all strata. Taken all together, these occurrences suggest human occupation of Rice Ridge during winter into spring in Early, Middle, and Late periods. Crested auklets were most likely available during late fall and winter. More than 88% of the crested auklets occur in strata C and D (Middle Period), suggesting catches of these birds during late fall and winter. Although they could not be identified to a taxon, single juvenile bones were found in strata C and J, indicating that these birds were taken in the summer before they had grown to adult size. While Stratum J derives from the Early Period, Stratum C derives from the Middle Period, and both fall within Ocean Bay I. The number of puffins in the assemblage is small. Given their seasonal distribution, puffins could have been taken in winter, although they were much more likely obtained in spring, summer, or fall when they are most abundant. At least one puffin bone is found in most strata, except for strata E and I. Overall, our assessment of year-round occupation of the site is consistent with Kopperl's (2003:105) results regarding the seasonality of site occupation.

Table 5. NISP of Mammals, fish, and birds from Rice Ridge by Strata K–A (from Kopperl [2003] and this paper).

Taxon	**Early**					**Middle**				**Late**		**Total**
	K	**J**	**I**	**H**	**G**	**F**	**E**	**D**	**C**	**B**	**A**	
Mammals												
Sea otter	90	374	136	482	132	288	105	165	152	78	18	2020
Harbor seal	15	84	16	119	69	134	47	53	73	63	27	700
Steller sea lion	9	36	7	85	4	5	6	13	10	5	9	189
Brown bear	8	19	21	8	6	6	3	5	15	3	—	94
Whale	—	55	—	2	1	—	—	—	3	—	—	61
Canid	—	3	—	8	2	3	2	4	8	5	2	37
Harbor porpoise	1	7	—	16	1	4	—	2	1	3	—	35
Red fox	1	1	2	3	—	3	—	3	6	—	—	19
Tundra vole	—	10	—	1	4	1	—	—	—	—	—	16
Other	—	1	1	6	—	6	2	1	2	1	1	21
Subtotal	124	590	183	730	219	450	165	246	270	158	57	3192
Fish												
Pacific cod	13	58	5	45	15	13	28	48	566	1689	268	2748
Salmonid	—	20	—	66	345	88	35	90	110	575	551	1880
Gadid	49	45	9	209	46	79	52	50	9	123	123	794
Cottid	2	—	2	37	2	11	2	10	56	121	19	262
Flatfish	4	20	1	32	6	22	9	7	18	22	5	146
Herring	—	13	3	16	—	2	9	14	9	10	2	78
Hexagrammid	—	—	1	37	2	9	1	—	—	5	5	60
Halibut	—	10	4	7	3	7	—	—	—	3	2	36
Other	—	1	1	—	—	—	—	—	—	3	—	5
Subtotal	316	1347	392	1909	857	1131	466	711	1308	2867	1089	12393
Birds												
Cormorant	52	260	59	123	35	141	74	83	135	98	15	1075
Ducks	34	163	39	140	37	135	59	153	188	149	23	1120
Murre	8	66	12	85	22	85	32	66	130	52	5	563
Geese	12	76	14	62	10	44	17	35	58	102	8	438
Larids	5	16	7	19	3	21	5	8	17	23	1	125
Crested auklet	—	1	—	—	—	4	3	53	25	1	1	88
Ptarmigan	—	1	—	2	2	10	8	23	6	12	—	64
Puffin	2	2	—	2	1	3	—	4	5	3	1	23
Pigeon guillemot	—	1	—	1	1	4	2	6	4	4	0	23
Loon	5	17	3	12	2	20	13	11	11	11	4	109
Other	2	15	1	12	3	22	16	28	10	6	1	116
Subtotal	120	618	135	458	116	489	229	470	589	461	59	3744

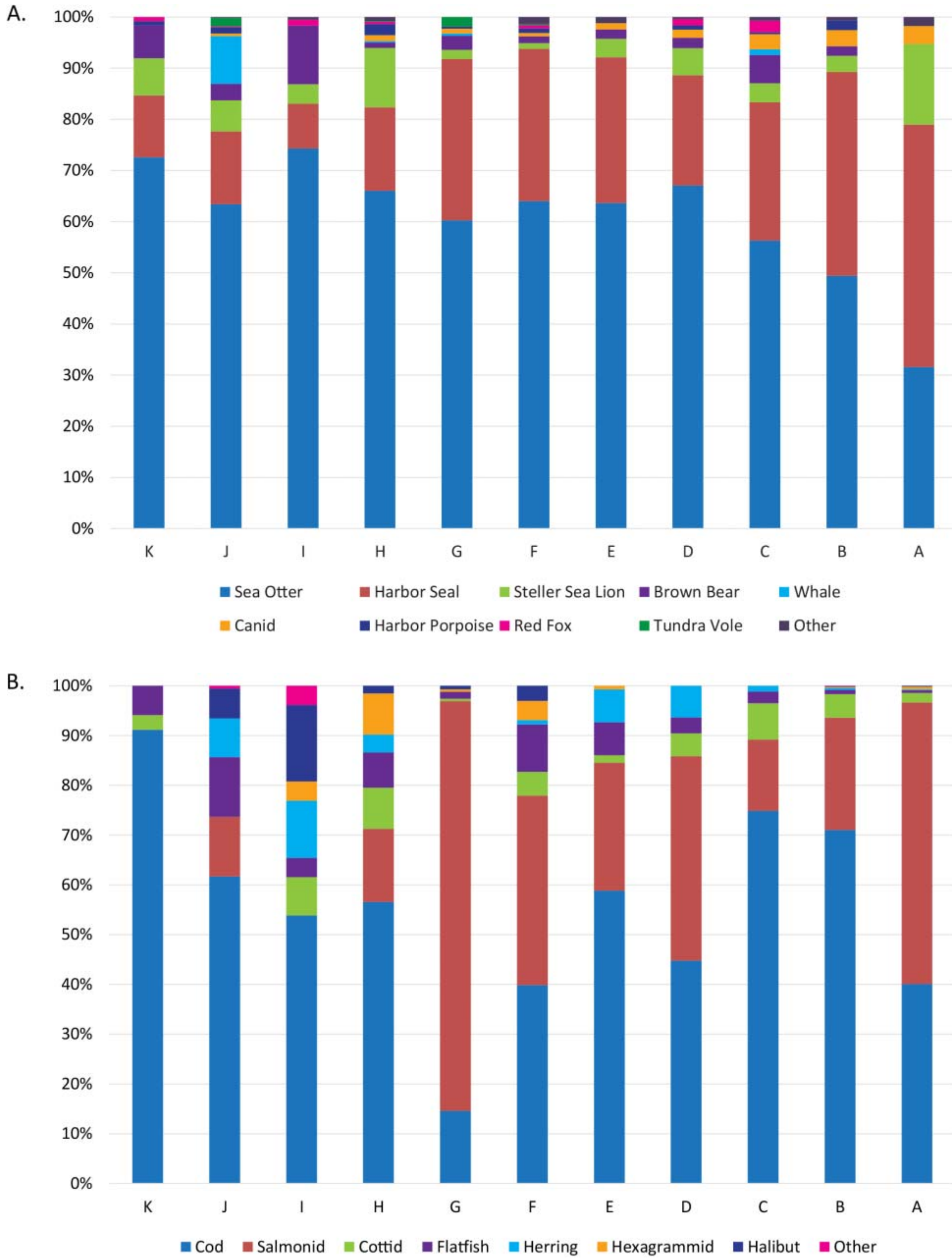

Figure 6. **% NISP of a) mammal, b) fish, and c) bird remains from Rice Ridge by stratum.**

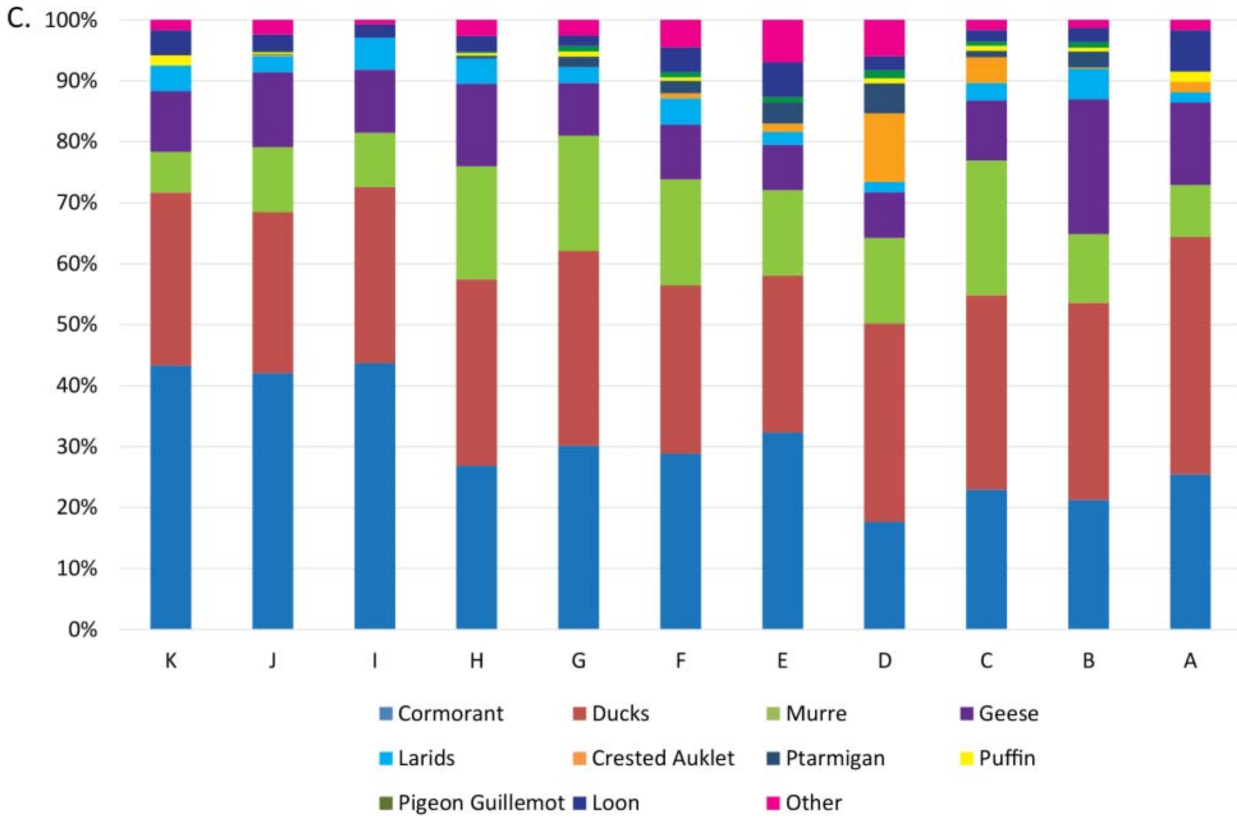

Figure 6. ***Continued***

Reevaluation of Seasonality at Rice Ridge Based on Bird, Mammal, and Fish Remains

As explained earlier, we analyzed bird remains from Units 2, 3, 5, and 6 at Rice Ridge because Kopperl (2003) analyzed the mammal and fish remains from these same excavation units. Table 5 and Figure 6 show our combined results, with the provision that taxa that occur in small numbers have been lumped as "other" for the purpose of this broader analysis. Note also that Pacific cod and gadid from Table 5 have been added together to comprise "cod" in Figure 6. Kopperl (personal communication 2021) explained that he identified vertebrae to gadid in order to be conservative, even though very few non-Pacific cod cranial, pectoral, or pelvic elements were identified as other gadids, such as walleye pollock, tomcod, or saffron cod.

Sea otter is the most abundant mammal throughout the sequence except for the most recent Stratum A when surpassed by harbor seal in this small sample. Sea otters could be hunted during any time of year, although offshore hunting in summer or good weather in spring and fall would be far easier and safer than in much of winter. The Alutiiq Museum (n.d.) maintains that Alutiiq did not hunt sea otters for food but for their fur: "freshly killed sea otters are traditionally taken to shore, skinned, given a drink of freshwater, and their bones buried or sunk to perpetuate the animal." The intensity of sea otter butchery increased over time at Rice Ridge (based on the frequency of cut marks)(Kopperl 2003:204, 282), with the implicit implication that they were consumed as food.

During Stratum J (Early Period), the number of whale remains is substantial, but whether this was more than one individual or was hunted or scavenged is unclear. The number and proportion of Steller sea lions in Stratum H (Early Period) suggest that some Rice Ridge residents targeted a haulout or breeding site, probably during the summer. The presence of higher proportions of juvenile harbor seal remains, as indicated by adult-specimen index values close to or <0.4 (see Kopperl 2003:210, 269) during strata I, H (Early Period), C (Middle Period), and B and A (Late Period) also indicates that deposition during summer contributed to the formation of these strata.

Pacific cod is the most abundant fish overall and dominates most of the Early Period (except for Stratum G). Pacific cod generally move closer to shore in late winter and early spring when they spawn, which would be the peak of their availability to fishers. Near Kodiak, according to Davydov (1977:232),

> there are a great many cod which arrive off the shore in great shoals at springtime. Even in winter they can be caught in the sea not far from the island if the weather is calm enough to let the baidarkas go out to fish" (see also Partlow and Kopperl [2011:212]).

Cod were eaten fresh just until the salmon runs began (Davydov 1977:232). Stratum G is the first deposit in which salmon dominate the fish; Kopperl (2003:97) noted several small pink salmon streams within 5 km of Rice Ridge and the Olds River at the head of Kalsin Bay, provided pink, coho, and chum salmon. We infer salmon availability extended from summer through fall; hence, Stratum G looks like a deposit at least partially resulting from summer-fall occupation. The Middle Period fish frequencies in strata F, E, and D are relatively small, but by the latest stratum of the Middle Period (C) and the Late Period (B, A), Rice Ridge residents had intensified their use of fish, both Pacific cod and salmon. By the Late Period, intensification of fishing indicates occupation (minimally) from late winter to spring, through summer and fall. The high proportions of salmonid in the Late Period may suggest salmon processing for storage, although this is conventionally viewed as a hallmark of the subsequent Kachemak Period (Fitzhugh 2003:229–231; Kopperl 2003: 165–166). Herring might be inferred as a spring indicator (when the fish mass inshore to spawn), although the numbers from Rice Ridge are quite low, no doubt because fine screens were not used in excavation recovery.

While the mammal and fish remains provide strong evidence of occupation in spring, summer, and fall, the birds demonstrate occupation in winter during all strata, evidenced by the consistently substantial numbers of ducks (especially common eiders and white-winged scoters), murres, geese, and loons. Winter occupation during the Middle Period is especially strong with the numbers of crested auklets (D, C) and ptarmigan (D). Summer use of birds is indicated by two juvenile bones and the small numbers of puffins, shearwaters, and albatross, but these numbers are low. The evidence of bird hunting is most substantial for winter and the shoulder seasons of fall and spring when winter migratory birds arrive or depart.

Taken all together, the evidence supports the occupation of Rice Ridge during all seasons, with sea otter and cormorant hunting possible across the yearly cycle; harbor seal and Steller sea lion hunting during spring and summer; cod fishing and duck, geese, and murre hunting during winter and early spring; and salmon fishing during summer and fall. If we were to have evaluated only one class of animals, we would have only a partial window into the seasonality of site occupation. The Rice Ridge bird analyses demonstrate how essential birds were as over-wintering resources to Alutiiq ancestors throughout the Ocean Bay period.

These analyses also reveal that the strata defined at Rice Ridge are palimpsests that represent more than use during single seasons. We recognize that we have only analyzed materials from four excavation units covering a 16 m^2 area, but even so, no stratum was deposited during a single season. This supports the idea that Rice Ridge was a semipermanent settlement from which Ocean Bay residents conducted a wide range of activities.

Comparison of Rice Ridge and Mink Island Bird Assemblages

The Mink Island archaeological site (49-XMK-030) is located on a small unnamed island in Amalik Bay along the shoreline of the Alaska Peninsula, also within Alutiiq/Sugpiaq territory. It is situated 142 km west of the Rice Ridge site, "as the crow flies," although separated from Kodiak Island by the sometimes-treacherous waters of Shelikof Strait. Katmai National Park personnel excavated the site's two loci during the summers of 1997 through 2000. Molly Casperson (2009, 2012) analyzed the Ocean Bay-period bird bones, with 87% of bird bones from an occupation dated 5400–4100 cal. BP, and the rest (13%) dating to 6500–5400 cal. BP (both from the "lower midden"). Due to limited chronological control and insignificant differences in the relative abundances of primary taxa between the two Ocean Bay components, we treat the bird remains from the lower midden at Mink Island as a single assemblage. Casperson (2009, 2012) identified 3,636 bird bones from Mink Island, which is a sample close in size to the 3,744 bird bones identified from Rice Ridge. The Mink Island assemblage is somewhat less species-rich than Rice Ridge, with 12 families, 26 genera, and 20 species of birds represented, compared to the 13 families, 34 genera, and 23 species at Rice Ridge. Figure 7 shows the Mink Island assemblage compared to the three Rice Ridge subassemblages, looking at the four most abundant taxa followed by those in the "other" category. Our statistical analysis compared the Mink Island and the combined Rice Ridge assemblage. This resulted in a very large and significant X^2 (1447.393, $p < 0.0001$). The adjusted residuals for each of the five categories are significant at the 0.05 level, with the greatest value for murres (See Supplementary Table 1).

At Mink Island, murres make up 57% of the assemblage. This occurrence is over twice the

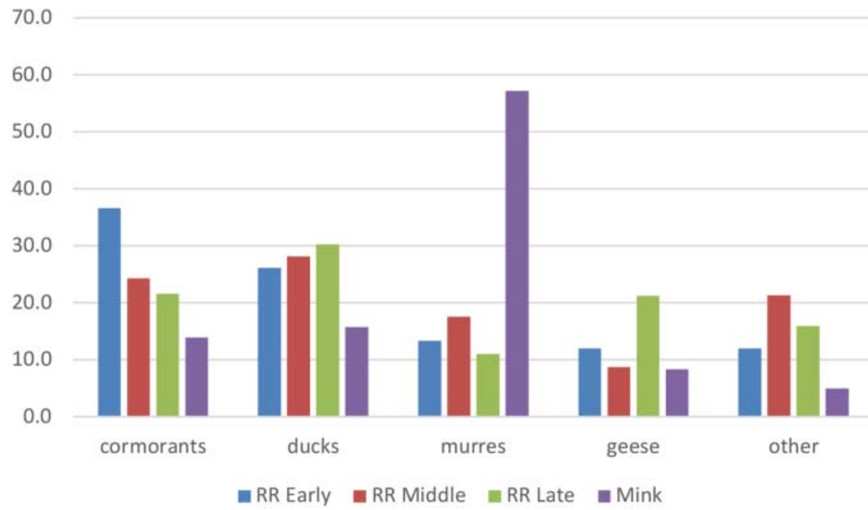

Figure 7. Rice Ridge birds compared to Mink Island birds (% NISP).

abundance for any period at Rice Ridge, even during the Middle Period, where murres reach their relative apex at 17.6% (Table 2, Fig. 4). It would appear that Mink Island residents were targeting murre colonies during the summer—murre colonies that were present in Ocean Bay times but not today. Casperson (2012:26) suggested that rising sea levels or earthquakes may have altered the Katmai coast in such a way that favorable murre breeding areas were destroyed, perhaps as recently as a few hundred years ago.

With regard to cormorants, all periods at Rice Ridge have higher percentages of cormorants than at Mink Island, where cormorants make up only 14% of the NISP, even though cormorant colonies currently occur in the vicinity of the site (Casperson 2012:25). The Early Period Rice Ridge subassemblage has the highest percentage of cormorants (36.6%), followed by that of Middle (24.3%) and Late periods (21.6%). The proportions of ducks and geese are also lower at Mink Island versus Rice Ridge. Mink Island also has a lower percentage of "other" taxa, suggesting it has a less diverse faunal assemblage compared to Rice Ridge. Applying the method described previously, we found the reciprocal of Simpson's index for the Mink Island assemblage to be 2.4, which is much below the diversity indices for the Rice Ridge subassemblages (Early: 4.27, Middle: 6.57, Late: 6.51).

The most abundant duck from Mink Island is the common eider at 58%, which is also the most abundant at Rice Ridge at 26%. Today, common eiders are not particularly abundant in the local environs (Casperson 2012:26), which is similar to the situation described herein for Rice Ridge. This situation suggests one or more of the factors previously mentioned: that archaeological common eiders are easier to identify because of their large size, that common eiders were more abundant in Ocean Bay times than today, and/or that common eiders have been adversely affected by modern conditions. With regard to geese, the percentages at Mink Island are comparable to those of the Middle Period at Rice Ridge (8.3% and 8.7%, respectively), but the implications of this are hard to evaluate in the absence of genus- or species-level identifications at both sites.

Concerning seasonality at Mink Island, we know that some geese, ducks (and common eider) were harvested during spring or summer based on Casperson's (2012:27) identification of medullary bone. This differs from Rice Ridge, where no medullary bone of any species has been identified. Based on the seasonal availability of most Rice Ridge birds, we have strong evidence for harvest from late fall through early spring. Most geese and ducks do not nest on Kodiak, whereas on the Alaska Peninsula, ducks and geese had access to numerous remote lakes and ponds for breeding. Casperson (2012:28) also identified juvenile cormorants and one cormorant specimen containing medullary bone supporting a late-summer occupation of Mink Island. These data suggested spring through late summer use of Mink Island, but Casperson (2012:27–28) also inferred residents inhabited the site during winter, based on modifications and burning of bird bones from carcasses hung to dry and smoke for storage and winter consumption (supporting earlier assertions by Schaaf [2007, 2009]).

The "other" taxa at Mink Island are quite similar to those at Rice Ridge, although the proportions of gulls, loons, small alcids, and ptarmigan are noticeably lower on Mink Island. The one ptarmigan bone from Mink Island may have derived from a bird on the Alaska Peninsula itself, while the other taxa were likely in the marine environment that surrounds the island. Casperson (2009, 2012) identified more species of scoters from Mink Island than we did at Rice Ridge, although the numbers of *Melanitta* sp. from Rice Ridge are greater. Relatively more pigeon guillemots were found at Mink Island than Rice Ridge, while crested auklets and gyrfalcon occur at Rice Ridge but not at Mink Island. These differences are fairly minor, with the main difference between the two sites being that during Ocean Bay times, Mink Island residents focused more on murres at their colonies, whereas at Rice Ridge, a wider variety of birds were more evenly harvested, especially in winter, bracketed by their migrations in fall and spring.

Conclusion

The Rice Ridge bird assemblage is worthy of the detailed analyses reported here because of the excellent bird-bone preservation at the site, the large quantities of bird bones recovered, and the importance of birds to Alutiiq ancestors. This is especially true for the Ocean Bay period, for which previous studies have emphasized marine-mammal hunting and fishing. Up until now, Casperson's (2009, 2012) work on the Mink Island bird assemblage was the only record of how important birds were during this time period in this region. Alutiiq ancestors' use of birds during Ocean Bay times is not one dimensional; the people occupying Mink Island relied upon birds in ways that differ substantially from how Rice Ridge residents used them as primary over-wintering resources. At Rice Ridge, Alutiiq ancestors depended heavily on the ducks (common eiders, white-winged scoters), murres, geese, and other taxa that winter in the Kodiak Archipelago after nesting in western Alaska and the Yukon-Kuskokwim Delta. These winter migrants, along with Pacific cod and probably shellfish, provided the critical resources that sustained Alutiit during a long, stormy winter. The Rice Ridge deposits demonstrate that people were experts at winter survival, relying upon birds for meat as well as raw materials to make clothing and tools. Taken together with the results on mammals and fish reported by Kopperl (2003, 2012), the well-preserved faunal remains from Rice Ridge provide a more holistic portrait of life during the Ocean Bay period. While Ocean Bay people were highly effective marine-mammal hunters and fishers, especially from spring through fall, it was Kodiak's abundance of birds in winter that ensured survival. Alutiiq ancestors consumed birds as food but also processed quantities of bird skins for warm and waterproofed clothing that was also fundamental to their getting through winter.

We also hope our study promotes more work on the Rice Ridge collections in general. Rice Ridge was one of the largest and most thorough excavations of one of Kodiak Island's oldest and best-preserved sites. Kopperl's (2003, 2012) seminal work on the chronology, stratigraphy, and analysis of the fish and mammal remains provides an excellent foundation for studies such as our own. The extensive artifact assemblage has never been analyzed or published, leaving it unknown to the archaeological profession, residents of Kodiak Island, and most importantly, Alutiiq descendants. We hope to inspire others to pursue additional study of the archaeology of Rice Ridge.

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Endnotes

1. Kopperl (2012:21, 23) refers to these as "occupation surfaces," as opposed to "floors" or "house floors." He states that these do not "connote an association with a particular kind of structure or house" (Kopperl 2012:23).

2. Following the logic of optimal foraging theory (OFT), geese would be considered high-ranked birds because of their large body size compared to other birds. The prey choice or optimal diet model would predict that people would first exploit high-ranked resources such as geese and that only when these became scarce or too costly to pursue would they turn to lower-ranked (i.e., smaller) birds such as ducks, murres, etc. For more on OFT, see Lupo (2007), Stiner and Kuhn (2016), and Winterhalder and Smith (2000).

3. Shannon (2021) reported these as Kittlitz's murrelets.

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