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RESEARCH ARTICLE

Archaeology and ethnobiology of Late Holocene bird remains from the northern Oregon coast

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Abstract

Archaeological bird remains from the Oregon coast provide important insight into local environments and the interactions between birds and people on the North American Pacific Coast. We contribute to this discussion with an analysis of bird remains from the Late Holocene Par-Tee site (35CLT20) in Seaside, Oregon. We sampled the Par-Tee avifaunal assemblage to near-redundancy, generating the largest sample from a single site on the Oregon Coast to date ($N = 7204$). The Par-Tee assemblage is dominated by nearshore or estuarine birds including scoters (*Melanitta* spp.) and Common Murres (*Uria aalge*), as well as pelagic Sooty Shearwaters (*Ardenna grisea*). Because of the large size of the sample, we identified unique species such as the California Condor (*Gymnogyps californianus*), which are currently endangered and face conservation challenges. Although the Par-Tee avifaunal assemblage is diverse, site residents appear to have focused on acquiring the most accessible species in the nearshore habitat complemented by opportunistic pelagic hunting and/or scavenging of beached birds. Most birds appear to have been processed for dietary consumption, with possible preferential use of larger-winged birds for tool manufacture. These findings underscore the value and challenges of using legacy collections for evaluating past human–environmental interactions in coastal and other aquatic regions.

KEYWORDS
birds, coastal, northwest coast, Oregon, zooarchaeology

1 | INTRODUCTION

Several studies have highlighted the important relationships between people and birds on the North American Northwest Coast, including research on subsistence practices, ritual, and other cultural and environmental developments from Alaska to northern California (Bovy, 2007; Bovy et al., 2019; Broughton, 2004; Butler et al., 2019; Funk, 2018; Moss, 2007). Along the southern Northwest Coast, Bovy et al. (2019) conducted a meta-analysis using avifaunal remains from 26 archaeological assemblages from the Oregon Coast, providing an important regional characterization of past bird use. This study found that people used a wide variety of birds that were largely obtained opportunistically through both scavenging and direct hunting, though they concluded that analysis of bird remains from Oregon is still limited (Bovy et al., 2019).

In this paper, we present a new analysis of a large sample ($N = 7204$) of bird remains from the Late Holocene Par-Tee site (35CLT20) in Seaside, Oregon. Our analysis of the Par-Tee bird remains takes advantage of a legacy collection from a massive excavation at the site in the 1960s to 1970s, including material from over 500 excavation units (Colten, 2015; Sanchez et al., 2018; Wellman et al., 2017). We compare our new analysis to the smaller subset of the Par-Tee bird remains previously analyzed by Colten (2015; see also Bovy et al., 2019) to determine if use of a larger sample size and strategy of sampling to redundancy yields significantly different results for species representation. We also revisit research questions

addressed in prior research, specifically which types of habitats were targeted for bird acquisition and likely acquisition methods. Finally, we explore the previously unaddressed question of how people at Par-Tee may have processed and used the birds they scavenged or hunted by examining element representation/completeness and other taphonomic evidence. Ultimately, our results have important implications for understanding past bird use and environmental change on the northwest coast, as well as the utility of legacy collections for zooarchaeological research worldwide.

2 | BACKGROUND

2.1 | The Par-Tee site

The Par-Tee (35CLT20) site is located in Seaside, Oregon, south of the mouth of the Columbia River (Figure 1). Par-Tee dates to 1850–1150 cal BP (Sanchez et al., 2018) and is located close to the shoreline (~200 m at present, likely closer pre-contact due to westward beach progradation; Losey & Yang, 2007). Geological data suggest that the Seaside area formerly contained an ancient bay/estuary or quiet-water environment (Connolly, 1995; Darienzo, 1992). The proximity of the site to open shoreline, rocky coast, riverine, and bay/estuary environments in the Seaside area provided a diversity of habitats and faunal species for people living in the area (Colten, 2015; Sanchez et al., 2020).

Par-Tee and two nearby sites—Palmrose (35CLT47) and Avenue Q (35CLT46)—were shell middens excavated between 1967 and 1977 by George Phebus and Robert Drucker (Phebus & Drucker, 1979). Phebus, Drucker, and their volunteers excavated ~1.5 × ~1.5 m (5 × 5 ft) units in arbitrary 30 cm (1 ft deep) levels and primarily used

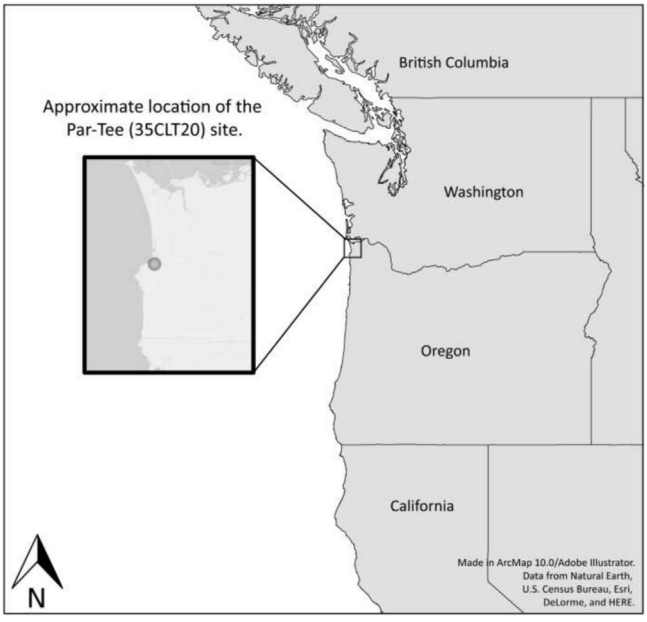

FIGURE 1 Approximate location of the Par-Tee site on the northern Oregon coast.

¼ inch screen mesh (Phebus & Drucker, 1979). Unit depths varied, reaching up to 6 ft (1.8 m) in some locations (Sanchez, 2021). The Par-Tee assemblage is curated at the National Museum of Natural History (NMNH) in Washington, DC.

Previous analyses of the Par-Tee fauna, including fishes, mammals, birds, and invertebrates, suggest the site is dominated by marine and estuarine species (Bovy et al., 2019; Colten, 2015; Grindle et al., 2021; Loiselle, 2020; Losey & Power, 2005; Losey & Yang, 2007; Sanchez et al., 2020; Wellman et al., 2017), but tens of thousands of bird, fish, and mammal bones remain unanalyzed. Similarly, the full artifact assemblage has yet to be described, but Par-Tee contains bone and stone tools, including bone harpoons used for hunting marine mammals and other animals (Sanchez, 2014), atlatls made from whale bone (Losey & Hull, 2019), and small bone and lithic points that could have been used to hunt birds. Bird bones were used to manufacture needles at Par-Tee (Losey, 2021), as well as items such as flutes and tube beads at Palmrose (Connolly, 1992, pp. 88–89; Phebus & Drucker, 1979) and Avenue Q (Connolly & Tasa, 2004). Bird bone beads, flutes, and needles were also found at coastal Oregon archaeological sites further south including Tahkenitch Landing (35DO130; Minor & Toepel, 1986), Seal Rock (35LNC14; Clark, 1991), and Whale Cove (35LNC60; Bennett & Lyman, 1991).

Seasonal patterns of the use of various animals at Par-Tee are poorly defined, in part due to the use of arbitrary levels during excavation. Most studies to date conclude a year-round occupation was likely (Sanchez et al., 2018) given the abundant mammal species representative of different seasons; for example, elk (*Cervus elaphus*) are indicative of a possible fall/winter occupation (Pearson, 1990), whereas sea otter (*Enhydra lutris*) pups (Wellman, 2021) and gray whales (*Eschrichtius robustus*; Wellman et al., 2017) indicate a possible spring/summer habitation. Because the site was excavated in arbitrary ~30 cm levels that cut across the site's stratigraphy, we do not attempt any analyses examining changes or trends of bird remains/use at the site through time.

2.2 | Ethnographic background

At Euro-American contact, the Seaside area was home to the Chinookan-speaking Clatsop (Deur, 2016) and Salish-speaking Nehalem Tillamook (Jacobs, 2003; Ray, 1938). Today, the descendants of these groups are represented by the Confederated Tribes of the Grande Ronde, Confederated Tribes of Siletz Indians, Confederated Tribes of Clatsop-Nehalem, and Chinook Indian Nation. Selected ethnographic accounts suggest diverse uses and roles of birds in this region historically and prior to contact, although caution should be exercised when applying ethnographic data to archaeological interpretations because of potential biases and deficiencies in the ethnographic record.

The Chinook and Tillamook reportedly hunted waterfowl using bow and arrow (Jacobs, 2003; Ray, 1938) and possibly nets and decoys (Suttles, 1990). The Chinook reportedly also used canoes camouflaged with tree boughs to form a blind to silently approach

waterfowl (Ray, 1938, p. 117). Both the Chinook and Tillamook apparently ate seagull eggs (Jacobs, 2003; Ray, 1938; Zobel, 2002). Clara Pearson, a Tillamook tribal member interviewed in the 1930s, reported that "Seagull eggs were gathered in numbers from rocks in the ocean. The men went considerable distances in canoes to hunt them […] they tasted like duck eggs, which were not plentiful (Jacobs, 2003, p. 83)" but the seagull itself was not eaten as "they always stayed poor" (Jacobs, 2003, p. 83). The Chinook would reportedly not eat crow, raven, seagull, owl, or eagle (Ray, 1938, p. 118), whereas the Tillamook used but did not eat Bald Eagle (*Haliaeetus leucocephalus*), woodpecker, and hummingbird (Zobel, 2002, p. 308). Food processing in Chinookan villages is thought to have occurred onsite (Ames & Sobel, 2013, p. 135), and cooking methods for meat among the Tillamook/Chinook (Jacobs, 2003, pp. 83, 76; Ames & Sobel, 2013, p. 135) and other coastal groups (Barnett, 1937) reportedly included boiling in troughs or baking in earthen ovens, corresponding with literature reviews which suggest boiling, roasting, and grilling of birds are common cross-culturally (Funk et al., 2016, p. 384).

Both the Chinook and Tillamook reportedly used wing bones to manufacture needles, flutes, or other implements (Ray, 1938, p. 135; Zobel, 2002, p. 309; Barnett, 1937); the Salmon River Tillamook used duck and geese in particular (Zobel, 2002). Among the Chinook, "bone needles were always relatively short, varying from eight to sixteen inches" (Ray, 1938, p. 135). Barnett (1937, p. 169) makes reference to a "Bird arrow, sharp (rabbit, squirrel, etc.)" used by the Tillamook and other Native Oregon communities, which seems to imply that the arrow is made from bird bone to hunt rabbit/squirrel. The Tillamook reportedly wore bird skin headgear (Barnett, 1937, p. 172), and for dances and ceremonies, the Chinook wore eagle feathers in their hair or in a headband and "down of the fish duck was sprinkled over the hair, whitening it" (Ray, 1938, p. 139). Eagle and hummingbird feathers were used for regalia and ceremonies (Ray, 1938, p. 139; Zobel, 2002); the Tillamook and other Oregon communities used woodpecker as currency in addition to ceremonial uses (Barnett, 1937, p. 174; Zobel, 2002, p. 309).

2.3 | Birds of the Oregon coast

The Oregon coast is home to a variety of bird species, both year-round and migratory. We highlight the species most relevant to the Par-Tee site here (Table 1). Several dabbling/diving ducks and geese are available year-round and/or seasonally; they frequent nearshore, estuary, and bay habitats. The most abundant of the Oregon alcids, the Common Murre (*Uria aalge*), is a year-round resident with well-known nesting colonies located along the coast (ODFW, 2023a). The Marbled Murrelet (*Brachyramphus marmoratus*) is a rare alcid that has experienced reduced breeding success and loss of their inland, old-growth forest canopy nesting habitat (Nelson, 2020). Other common Oregon coast birds include cormorants and gulls. Pelagic, seasonal species include shearwaters and albatross. The Sooty Shearwater (*Ardenna grisea*) is particularly abundant during the summer months when they forage ~3–6 miles offshore (Carboneras et al., 2020b; ODFW, 2023b). Although still relatively abundant, numbers of Sooty

TABLE 1 Summary of relevant bird species/families on the Oregon coast (following Bovy et al., 2019).

Family/species	Preferred habitat	Seasonality	Beaching/wrecking behavior
Diving Ducks (scoters)	Foraging offshore, also found nearshore and/or in estuarine/bay environments (Anderson et al., 2020).	Winter visitor, migrating spring/fall.	Likely to wreck (Bovy et al., 2019).
Dabbling Ducks	Shallow waters inland and coastal, e.g., tidal flats, estuaries (ODFW, 2023c).	Year-round and/or seasonal.	
Geese	Shallow waters inland and coastal, e.g., tidal flats, estuaries (ODFW, 2023c).	Year-round and/or seasonal.	
Common Murres	Nearshore. Nesting colonies on rocky cliffs (ODFW, 2023a).	Year-round.	Likely to beach/wreck (Bovy et al., 2019).
Marbled Murrelets	Nearshore. Nesting old-growth forest canopy (Nelson, 2020).	Year-round.	
Sooty Shearwaters	Foraging offshore, pelagic shelf/slope waters (Carboneras et al., 2020b; ODFW, 2023b).	Summer visitor.	Likely to beach (Bovy et al., 2019).
Northern Fulmars	Foraging offshore, pelagic shelf/slope waters (Mallory et al., 2023).	Winter visitor.	Likely to beach/wreck (Bovy et al., 2019).
Gulls	Nearshore and inland marine and freshwater habitats. Nesting on rocky cliffs, headlands, offshore islands (Winkler et al., 2020).	Year-round and/or seasonal.	Likely to beach (Bovy et al., 2019). Opportunistic scavengers; may seek out human trash heaps.
Cormorants	Nearshore/estuarine. Variety of nesting habitat, e.g., rocky cliffs, offshore islands, nearshore (Dorr et al., 2021; Hobson 2021; Wallace & Wallace, 2021).	Year-round.	Likely to beach (Bovy et al., 2019).
Albatrosses	Pelagic shelf/slope waters (Carboneras et al., 2020a).	Summer (black-footed) and early fall (short-tailed) visitors.	

Shearwaters have been declining because of climate change, nesting habitat loss, and bycatch deaths (Carboneras et al., 2020b; Clucas, 2011; Humphries & Möller, 2017; Jones, 2000). The Short-tailed Albatross (*Phoebastria albatrus*) is endangered because of severe population decline from 19th-century commercial hunting and is primarily spotted along the northern Pacific rim (Carboneras et al., 2020a), but juvenile individuals have been documented along the US West coast, usually in early fall (Carboneras et al., 2020a; USFWS, 2021). Certain species/families are prone to behaviors such as beaching or "wrecking," washing ashore in large numbers after a mass mortality event, which may influence how people in the past acquired the birds (Table 1; Bovy et al., 2019).

2.4 | Previous avifaunal research

Previous analyses of bird remains from the Seaside sites include samples from Par-Tee (NISP = 1396; Colten, 2015), Palmrose (NISP = 1337; Colten, 2015; Greenspan & Crockford, 1992), and Avenue Q (NISP = 381; Greenspan & Crockford, 1992). All of these data were synthesized in Bovy et al.'s (2019) meta-analysis of avifaunal remains from 26 coastal Oregon archaeological sites. Bovy et al. (2019) compared (1) the taxonomic composition of sites across different habitats, (2) taxonomic diversity between archaeological sites, and (3) tested for correlation between taxonomic composition and modern beached bird records. Par-Tee exhibited a relatively high taxonomic diversity and contained large proportions of alcids (24%–52%, particularly Common Murres), shearwaters (12%–20%), and ducks (20%–40%; Bovy et al., 2019). The Par-Tee assemblage composition correlated with its "intermediate" habitat type: access to both open coast/pelagic species and nearshore/estuarine species. The Par-Tee avifaunal taxonomic composition was statistically similar to that of the Coastal Observation and Seabird Survey Team (COASST) modern beached bird database (Bovy et al., 2019), probably driven by the Common Murre—the top beached bird (31.48% of all beachings/wrecks in northern Oregon 2001 to present) based on data from the COASST website (2024). These data, particularly Colten's sample from Par-Tee, provide a framework for comparing the bird remains we analyzed from Par-Tee to previous research at Seaside and beyond.

3 | MATERIALS AND METHODS

3.1 | Zooarchaeological analyses

Megan Spitzer in the Division of Birds at NMNH made taxonomic identifications of Par-Tee bird remains using reference specimens in the NMNH Division of Birds. To aid in the comparability of our analysis with other faunal studies and to help explain the basis for our taxonomic identifications, a list of reference specimens used to make identifications is available in Supporting Information (Table S3). All elements were identified for all species; however, only vertebral ribs with an intact head (capitulum) were identified (NISP = 56). Elements were identified to the lowest possible taxonomic level using multiple reference specimens based on comparisons of morphological traits and size, as well as select print references (Broughton, 2004; Woolfenden, 1961). Immature specimens were identified based on bone porosity and generally identified to size class, but bones that were sufficiently developed to exhibit diagnostic markers were identified to the lowest possible level using both adult and juvenile comparative specimens (Table S1).

Because of morphological similarities between some closely related taxa, we grouped difficult-to-distinguish species by genus, family, or other higher taxonomic group consistent with other Northwest Coast bird analyses (e.g., Bovy et al., 2019; Taivalkoski et al., 2021). These include grouping scoters as *Melanitta* spp. and gulls, geese, dabbling ducks, and diving ducks by size (Table 2). We also further grouped results by family before performing the quantitative analyses described below. In the interest of reporting all data, the full list of species identified is provided in the Supporting Information (Table S2) for comparison to the more conservative identifications provided in Table 2. However, species identifications for the groupings noted above should be treated with caution until further analyses (e.g., genetic) can definitively confirm those identifications. All bones were examined for the presence of modifications, cutmarks, distinct pathologies, and other morphological traits and characteristics (Table S1). Naming conventions follow the most recent Clements Checklist (Clements et al., 2023).

3.2 | Sampling strategy

Bird remains from 40 Par-Tee excavation units were analyzed. The units selected for sampling were strategically chosen to maximize coverage of the site area (Figure S1) and expand on Colten's (2015) previous analysis of bird bones from six units. A rough estimate of the volume analyzed in these 40 units is 131 m^3 (~4625^3 ft; based on ~185 30 cm [1 ft] levels of 1.5 × 1.5 m [5 × 5 ft] units). The initial goal of the analysis was to sample to redundancy (Lyman & Ames, 2004) but as analysis progressed one or two new taxa were continually being identified. These taxa occur in small numbers (<.25% of the assemblage) and are potentially important for future studies of rare/endangered species (e.g., the California Condor [NISP = 2; .02% NISP], Marbled Murrelet [NISP = 3; .04% NISP], and Bald Eagle [NISP = 12; .16% NISP] specimens). Based on the sampling curve (Figure S2), further analysis might yield additional species identifications (including potentially rare taxa) but would be unlikely to affect our conclusions regarding the species and habitats utilized by the Par-Tee inhabitants.

3.3 | Quantitative analyses

We used statistical tests to determine if sampling to redundancy with our large sample provided different taxonomic results compared with the smaller sample size analyzed by Colten (2015). We grouped

TABLE 2 Bird identifications from the Par-Tee site.

Common name	Species	NSP
Small Geese	*Branta* spp., small	48
Greater White-fronted/Canada Goose	*Anser albifrons/Branta canadensis*	265
Tundra Swan	*Cygnus columbianus*	7
Blue-winged/Cinnamon Teal	*Spatula discors/cyanoptera*	8
Gadwall/American Wigeon	*Mareca strepera/americana*	3
Mallard	*Anas platyrhynchos*	19
Dabbling duck	Anatini	16
Canvasback/Greater Scaup	*Aythya valisineria/marila*	16
Lesser Scaup/Ring-necked Duck	*Aythya affinis/collaris*	13
Diving duck	*Aythya* sp.	5
Harlequin Duck	*Histrionicus histrionicus*	1
Scoters	*Melanitta* spp.	2092
Long-tailed Duck	*Clangula hyemalis*	1
Bufflehead	*Bucephala albeola*	1
Common/Barrow's Goldeneye	*Bucephala clangula/islandica*	8
Hooded Merganser	*Lophodytes cucullatus*	16
Common/Red-breasted Merganser	*Mergus merganser/serrator*	27
Small goose/large duck	Anatidae	4
Ruffed Grouse	*Bonasa umbellus*	1
Pied-billed Grebe	*Podilymbus podiceps*	4
Horned Grebe	*Podiceps auritus*	4
Red-necked Grebe	*Podiceps grisegena*	10
Eared Grebe	*Podiceps nigricollis*	2
Western/Clark's Grebe	*Aechmophorus occidentalis/clarkii*	40
Grebe	Podicipedidae	1
Band-tailed Pigeon	*Patagioenas fasciata*	3
Virginia Rail	*Rallus limicola*	1
Common Gallinule	cf. *Gallinula galeata*	1
American Coot	*Fulica americana*	3
Black-bellied Plover	*Pluvialis squatarola*	2
Whimbrel	*Numenius phaeopus*	3
Ruddy/Black Turnstone	*Arenaria interpres/melanocephala*	1
Pectoral Sandpiper	*Calidris* cf. *melanotos*	1
Greater Yellowlegs	*Tringa melanoleuca*	1
Jaeger	*Stercorarius* sp.	4
Common Murre	*Uria aalge*	1488
Pigeon Guillemot	*Cepphus columba*	8
Marbled Murrelet	*Brachyramphus marmoratus*	3
Cassin's Auklet	*Ptychoramphus aleuticus*	11
Rhinoceros Auklet	*Cerorhinca monocerata*	1
Tufted Puffin	*Fratercula cirrhata*	6
Black-legged Kittiwake	*Rissa tridactyla*	17
Bonaparte's Gull	*Chroicocephalus philadelphia*	5
Medium Gulls	*Larus* spp., medium	159
Large Gulls	*Larus* spp., large	241
Red-throated/Pacific Loon	*Gavia stellata/pacifica*	127

(Continues)

TABLE 2 (Continued)

Common name	Species	NSP
Common Loon	*Gavia immer*	17
Loon	*Gavia* sp.	3
Black-footed Albatross	*Phoebastria nigripes*	3
Short-tailed Albatross	*Phoebastria albatrus*	372
Albatross	*Phoebastria* sp.	3
Storm-Petrel	*Hydrobates* sp.	2
Northern Fulmar	*Fulmarus glacialis*	28
Pink-footed Shearwater	*Ardenna* cf. *creatopus*	1
Sooty Shearwater	*Ardenna grisea*	1044
Brandt's Cormorant	*Urile penicillatus*	44
Pelagic Cormorant	*Urile pelagicus*	118
Double-crested Cormorant	*Nannopterum auritum*	47
Cormorant	Phalacrocoracidae	29
Brown Pelican	*Pelecanus occidentalis*	61
Great Blue Heron	*Ardea herodias*	2
California Condor	*Gymnogyps californianus*	2
Osprey	*Pandion haliaetus*	2
Bald Eagle	*Haliaeetus leucocephalus*	12
Hawk	*Buteo* sp.	4
Western Screech-Owl	*Megascops kennicottii*	2
Great Horned Owl	*Bubo virginianus*	3
American Crow	*Corvus brachyrhynchos*	46
Common Raven	*Corvus corax*	1
Varied Thrush	*Ixoreus naevius*	3
American Robin	*Turdus migratorius*	1
medium bird (ibis/spoonbill?)	aff. Threskiornithidae	1
Large bird	Large Aves	23
Medium/large bird	Medium/large Aves	19
Medium bird	Medium Aves	14
Small/medium bird	Small/medium Aves	3
Unidentified bird	Aves	596
	Total	7402

our results by major taxa (Table 2) following Bovy et al. (2019, tbl. 4) to ensure direct comparisons at similar resolutions. To measure taxonomic diversity, we used the reciprocal of Simpson's Index following Bovy et al. (2019). To compare the results of major taxa identified by Colten (2015) to our sample, we used g-tests of independence (McDonald, 2014; Sokal & Rohlf, 1981) which test whether the quantity (NISP or % NISP of a given taxonomic group) differs between variables (Colten's 6 units of material compared to our 40 units).

To evaluate potential patterns in how different bird taxa may have been processed and used, we examined element representation (% NISP) and completeness (% NISP of element portions) for the assemblage and major taxonomic groups. We discuss these results drawing upon an experimental study by Funk et al. (2016) in which chickens were cooked (boiled, grilled, and roasted) and eaten to examine "discard packages": elements discarded after eating. Key insights included dismemberment cleave/chop marks on coracoids, humeri, sternums, synsacrums, and femora, and appendicular "discard packages" of (1) femur and tibiotarsus/fibula disarticulated or articulated, (2) whole wing articulated, (3) ulna/radius/phalanges articulated, or (4) the humerus alone (Funk et al., 2016, p. 386).

We also calculated the wing-to-leg ratio (N of wing elements/N of leg elements) described by Bovy (2002), which evaluates whether wing (humerus, ulna, radius, carpometacarpus) or leg elements (femur, tibiotarsus, tarsometatarsus) are present in expected abundances. The expected ratio is based on two humeri, ulnae, radii, and carpometacarpi in each of the wings (total of 8), and two femora, tibiotarsi, and tarsometarsi in each of the legs (total of 6), yielding a ratio of 8/6 or

1.3 for a whole bird (Bovy, 2002, p. 972). Bovy (2002) used this ratio to evaluate whether bone density/differential preservation could account for the phenomenon of the relative wing abundance in avifaunal assemblages; we use this ratio to more generally evaluate relative wing/leg abundance at the Par-Tee site.

4 | RESULTS

4.1 | Zooarchaeological analyses

We analyzed 7204 bird specimens (Table 2). A large number (NISP = 6549) were identifiable at or below family level, and 655 were unidentifiable beyond Aves (e.g., medium bird). At least 22 families and at least 62 species are represented, although the number of species may be higher (Table S2) since we did not count birds difficult to differentiate/of similar size as separate species (Table 2). The three most abundant taxa by both count (NISP; Table 2) and percent of the total (% NISP; Figure 2) are scoters (*Melanitta* spp.), alcids (mostly Common Murres), and shearwaters (mostly Sooty Shearwaters), followed by gulls (*Larus* spp.), Short-tailed Albatross, and geese. Small numbers (sometimes a single specimen) of rare species include the California Condor (NISP = 2) and Marbled Murrelet (NISP = 3).

The majority of specimens are adult individuals, but a small number are juveniles (NISP = 198; Table S1), represented primarily by cormorants and scoters, with smaller amounts of murres, gulls, and albatross, and single specimens of grebes, dabbling ducks, geese, and loons.

A small percentage of the identified specimens (NISP = 213, ~3% NISP) exhibit modifications. Cutmarks are the most common (NISP = 123), especially to proximal wing and leg bones. Several humeri (NISP = 11) have indented olecranon fossae (Figure 3) because of hyperextension of the ulna. The most frequently modified species were scoters, shearwaters, murres, and albatross, although occasional cutmarks or modifications to single species were noted (Table S1). Gnawing and/or tooth punctures from humans/carnivores were recorded (NISP = 86), often on distal/proximal long bones; however, we cannot state with certainty whether this reflects human dietary consumption or scavenging by carnivores/dogs at Par-Tee (see also Wellman, 2021, 2022).

Patterns of processing and deposition are difficult to evaluate because of the arbitrary excavation levels; however, several unit levels appeared to contain individual bird carcasses based upon the recovery of proportionally sized elements including pairs (i.e., left and right) of several of the major appendicular elements. The American Crow and Black-legged Kittiwake (provenience SW21G-6), likely Herring Gull (SW22C-8), and juvenile cormorant (SE5F-5) specimens may be single individuals.

FIGURE 3 Damage to the olecranon fossa of a Sooty Shearwater humerus (unit NE15F-4) resulting from hyperextension of the ulna. [Colour figure can be viewed at wileyonlinelibrary.com]

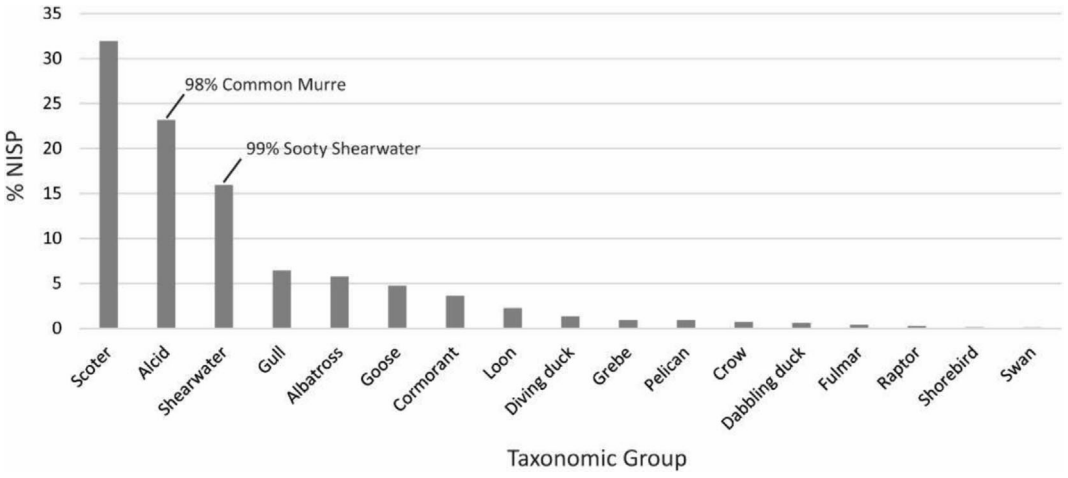

FIGURE 2 Percent NISP (% NISP) of major taxonomic groups in the Par-Tee avifaunal assemblage. Additional taxonomic groups representing less than .1% NISP (rails, owls, birds of prey, songbirds, etc.) are excluded.

4.2 | Quantitative analyses

The reciprocal of Simpson's Index for our larger Par-Tee sample is 4.11. The g-test results (Table S4) from comparing major taxonomic groups between our and Colten's (2015) Par-Tee samples are insignificant for % NISP ($p = 0.99$, $\alpha = 0.05$) but significant for NISP ($p = 0.002$, $\alpha = 0.05$).

Element representation (Table 3) for the total sample is dominated by humeri (~15% NISP), tibiotarsi (~12% NISP), and ulnae (~10% NISP), consistent with previous avian faunal analyses in which element representation is dominated by wing bones (Bovy, 2012). Wing bones also dominate when element representation is calculated (% NISP) by major taxonomic group, with a few exceptions (Figure 4 and Table S5): tibiotarsi and/or tarsometarsi rank in the top three for six groups, respectively, whereas pedal phalanges rank 2nd for albatross. Vertebrae are the only axial element to rank in the top three (2nd for cormorants).

Assemblage-wide, carpometacarpi, femora, and tarsometatarsi were most often recovered as complete specimens, whereas humeri and tibiotarsi were highly fragmented (Figure S3). Element completeness for major taxonomic groups (Figures S4–S10) is described in detail in the discussion, but roughly similar patterns in element completeness are seen between albatross/geese, murres/scoters, shearwaters, gulls, and cormorants.

The wing-to-leg ratios for Par-Tee taxonomic groups range from 0.89 to 3.24 (Table S6). The expected ratio for a complete skeleton is 1.3, meaning more wing elements than expected are present in the Par-Tee avifaunal assemblage for all major taxonomic groups apart from shearwaters (0.89).

TABLE 3 Element representation calculated as % NISP of identified specimens.

Element	NISP	% Total NISP
Humerus	1054	14.63
Tibiotarsus	841	11.67
Ulna	743	10.31
Femur	571	7.93
Coracoid	549	7.62
Carpometacarpus	443	6.15
Radius	384	5.33
Tarsometatarsus	357	4.96
Vertebra	315	4.37
Pelvis	268	3.72
Scapula	218	3.03
Sternum	204	2.83
Mandible	145	2.01
Pedal phalanx	110	1.53
Furcula	91	1.26
Proximal phalanx major digit	78	1.08
Rib	56	0.78
Maxilla	44	0.61
Skull	48	0.67
Fibula	22	0.31
Distal phalanx major digit	12	0.17
Quadrate	8	0.11
Ulnar carpal	3	0.04
Alular phalanx	3	0.04

5 | DISCUSSION

5.1 | Sampling to redundancy and taxonomic representation

The larger sample size reported here resulted in a higher measure of taxonomic diversity (reciprocal of Simpson's Index of 4.11) compared with Colten's (2015) smaller analysis (index of 3.85; Bovy et al., 2019). When compared with the indices for the Oregon sites analyzed by Bovy et al. (2019, tbl. 7), the larger Par-Tee sample moves the site higher in rank of taxonomic diversity, from 5th to 3rd, below only the Netarts Sandspit (35TI1; index of 7.31) and Yaquina Head (35LNC62, index of 5.66) sites.

The g-test of independence comparing NISP between our sample and Colten's (2015) sample is statistically significant, whereas the % NISP is not. This suggests smaller samples may still capture overall taxonomic composition, at least when measured at a conservative level of major taxonomic groups.

Although the taxonomic composition calculated by % NISP may not be statistically significant, our expanded sample size yielded additional identifications (at least 62 species) compared with the smaller sample (at least 26 species; Colten, 2015). We report a greater variety of species for dabbling and diving ducks, shorebirds, and alcids, in addition to very small quantities of previously unidentified species like owls, songbirds, and currently endangered species like the California Condor and Marbled Murrelet. Several of the species identified in small numbers in this analysis (diving ducks, Ruffed Grouse, Marbled Murrelet, and owl) were not found in the smaller Par-Tee sample analyzed by Colten but were present in the Palmrose sample (Colten, 2015). The Palmrose and Par-Tee sample sizes analyzed by Colten were roughly similar, and birds comprised similar percentages (~10% NISP at Palmrose and ~11% NISP at Par-Tee, respectively), but Par-Tee remains a larger assemblage overall. Sampling to redundancy may be useful in capturing the full representation of species at the same site; however, future research of a larger sample from Palmrose could help clarify how sample size may influence taxonomic diversity between sites.

5.2 | Habitat exploitation and bird acquisition by Par-Tee inhabitants

Par-Tee was located near both the open coastline and a probable bay/estuary, and the species abundances reported here and in Bovy

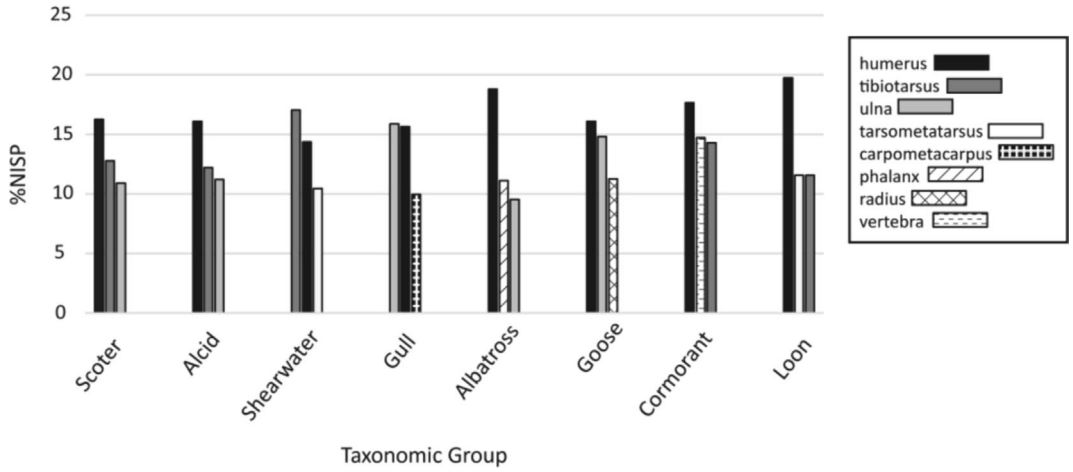

FIGURE 4 The top three abundant elements (by % NISP) for each of the major taxonomic groups in the Par-Tee site. Humeri rank in the top three for all groups, tibiotarsi for six, and ulnae for four. Exceptions are the high abundance of albatross pedal phalanges and cormorant vertebrae.

et al. (2019) are consistent with acquisition from these habitats. Diving and dabbling ducks, geese, and more variably murres, cormorants, and gulls, are all likely to have frequented the quiet-water environment. The flocking/rafting behavior of the anatids may have enabled particularly efficient hunting with bow and arrow or nets. However, Par-Tee does contain a substantial quantity of pelagic species including Sooty Shearwaters and Short-tailed Albatross, suggestive of offshore habitat exploitation and acquisition.

Despite proximity to the open coast, few shorebird species are present in the Par-Tee assemblage (Table 2), possibly a result of shorebird behavior (generally more elusive/solitary) and/or smaller shorebird bones passing through the ¼ inch mesh used for screening. Species likely collected from the open coast/shoreline include species prone to wrecking (scoters, murres) and/or beaching (murres, shearwaters, fulmars, gulls, auklets). Hunting of seabirds is difficult to distinguish from beach scavenging in the archaeological record, but the Par-Tee site had a similar taxonomic composition to the COASST dataset, likely due to the abundance of murres which often beach or wreck in the fall because of post-breeding mortality and could therefore have been collected on the beach in large quantities following mass die-offs (Bovy et al., 2019, p. 30).

Gulls and some cormorant species nest in coastal rocky areas. Par-Tee contained several juvenile cormorants (NISP = 80), indicative of possible fledgling hunting at cormorant rookeries as has been suggested in both the ethnographic (Barnett, 1937; Bovy et al., 2019; Losey, 2002) and archaeological record for Oregon (Bovy et al., 2019), including at the Netarts Sandspit (Losey, 2002) and Whale Cove (Watson, 2011) sites. Gull eggs were reportedly a preferred food and may have been sourced at sea with great effort per Clara Pearson's account. Although the gulls were not a preferred food, they may have been hunted opportunistically while collecting eggs or if found scavenging in trash heaps at Par-Tee.

The preferred habitats of albatrosses and shearwaters are pelagic shelf and slope waters. Although Sooty Shearwater abundance may be driven by beaching/wrecking behavior, in the present day, they can be seen congregating ~3 to 6 miles offshore while migrating (ODFW, 2023b). Albatross tend to remain fully offshore and are unlikely to beach according to COASST data (Bovy et al., 2019), although this may be due to modern, low populations. Prior studies of cetacean remains from Par-Tee concluded that Indigenous peoples of the Oregon coast were conducting, at least, opportunistic offshore hunting of whales in the Seaside area prior to contact (Losey & Yang, 2007; Sanchez et al., 2016; Wellman et al., 2017, 2024). If Par-Tee inhabitants were occasionally hunting cetaceans offshore, perhaps albatross and shearwaters were also opportunistically taken during such outings (a similar explanation has been proposed for the albatross found in the Makah Ozette site [45CA24] faunal assemblage [DePuydt, 1994, p. 230]). Additionally, birds are attracted to feeding whales that tend to stir prey up from deeper waters; perhaps the presence of feeding birds offshore even alerted hunters to the presence or location of a whale (e.g., a modern study from Massachusetts/Maine shows Great Shearwater and Humpback whale presence overlaps [Silva et al., 2022]).

New isotopic data on sea otter remains from Par-Tee suggest that kelp forest habitats, which have minimal coverage on the central/northern Oregon coast today (Tinker et al., 2023), may have been more extensive in the Seaside area prior to contact (Pers. Comm., Elliot Smith/Wellman, March 3, 2024). Kelp forest habitats would have attracted mammals found at Par-Tee such as Gray whales, Harbor seals (*Phoca vitulina*), and sea otters (Wellman, 2021), and a wide variety of birds including gulls, cormorants, scoters, pelicans, shearwaters, and even birds typically considered estuarine or shore-based like grebes (Pers. Comm., Roy Lowe III, March 9, 2024). Kelp forests may have attracted aggregations of birds that could then be efficiently hunted, or the birds may have been taken opportunistically during hunting for species like sea otters (see Monks', 1987 "prey as bait" subsistence strategy).

5.3 | Bird use at the Par-Tee site

To gain insight into how different species may have been processed at the Par-Tee site, we consider element representation/completeness, cutmarks, gnawing, and ethnographic analogy for key species.

5.3.1 | Murres and scoters

Common Murres and scoters are the two most abundant taxa, with remains dominated by humeri, ulnae, and tibiotarsi (Figure 4). Murre/scoter element completeness patterns (Figures S4 and S5) and wing-to-leg ratios (Table S6) are remarkably similar: murre (and to a lesser degree, scoter) elements are the most complete out of the taxa discussed except for humeri/tibiotarsi, and both wing-to-leg ratios are the closest to a complete skeleton of the other taxonomic groups. Carpometacarpi are noticeably complete (>50% NISP) and may be due to the small size of the taxa/relative compactness of bones. Murre and scoter elements frequently exhibit cutmarks (NISP = 14 and 34) and gnawing (NISP = 15 and 28). Approximately 50% of murre elements with cutmarks are coracoids, possibly indicative of meat removal for dietary consumption (following Funk et al., 2016). The majority of scoter elements with cutmarks are femora/tibiotarsi, possibly reflective of lower limb processing for dietary consumption.

Based on abundance, similar patterns of element completeness, and the likelihood of murres/scoter being harvested en masse due to flocking, wrecking, and beaching behaviors, we suggest that these taxa were acquired and processed using similar strategies. We suggest that whole murres/scoters were brought on site (based on relatively normal wing-to-leg ratios and relative representation of murre skull elements; Table S5) where they were likely used for dietary consumption and possible tool manufacture. Murres and scoters may also have been cooked in large numbers. Funk et al. (2016, p. 387) reported that the wing elements of the boiled chickens slipped away easily from the humerus, which sometimes remain attached to the carcass—murre/scoter carpometacarpi/ulnae/radii may have been easily pulled away and deposited in the midden, representing a dietary "discard package" along with femora (following Funk et al., 2016).

5.3.2 | Sooty shearwaters

Sooty Shearwaters are the third most abundant taxa, with remains dominated by humeri, tibiotarsi, and tarsometarsi. Shearwater elements frequently exhibit gnawing ($N = 14$) and cutmarks ($N = 23$); like murres, ~50% of elements with cutmarks are coracoids, indicative of processing for dietary consumption. Despite being of similar size to scoters/murres, complete Sooty Shearwater elements are dominated by femora (~60%; a dietary "discard package") and carpometacarpi (~37%; Figure S6) and are the only taxon to have a low wing-to-leg ratio (Table S6), suggesting possible differences in processing, perhaps related to differences in acquisition (e.g., not en masse), a focus on dietary consumption (resulting in more femora), or a focus on wing bones for tool manufacture (resulting in a lower wing abundance). The Par-Tee site represents a possible population for future study: Sooty Shearwaters are in decline today, and future research including ancient DNA and isotope analyses on archaeological remains may help to establish historical baselines applicable to future conservation efforts.

5.3.3 | Albatross and geese

Geese and albatross elements are dominated by humeri/ulnae, radii (geese), and pedal phalanges (albatross). Geese/albatross elements are rarely complete (Figures S7 and S8); the elements of large birds, particularly wing bones, are prone to fragmentation while simultaneously remaining identifiable because of their size, which may have contributed to the high NISP and over-representation of wings relative to legs for these taxa at the site (Table S6). However, total geese wing elements dominate the geese NISP (60% NISP; Table S5) relative to other species (e.g., ~40% NISP for albatross and ~50% NISP for gulls, respectively); it seems unlikely that fragmentation alone accounts for wing bone dominance. Both albatross and geese have a lower % NISP of femora and tibiotarsi compared with other taxa, and albatross have fewer carpometacarpi (Table S5). Albatross elements also frequently exhibit cutmarks ($N = 18$) and are the only taxa to be represented by a large proportion of pedal phalanges. The pedal phalanges of albatross are quite large which may be driving the over-representation but when paired with albatross skull representation (Table S2) is useful in demonstrating that albatross appear to have been transported whole to the site despite their size prior to processing.

Because of their size, geese/albatross elements were likely fragmented more than other species following dietary consumption and use of bone for tool manufacture. Geese and albatross carpometacarpi may be incomplete because of size-related fragmentation, but perhaps skins/feathers were removed from these species preferentially, breaking carpometacarpi in the process. Only 10 ulnae have cutmarks: five are albatross and two are geese, and one ulna of each was cut near the papillae (Table S1). The lower abundance of goose/albatross leg bones may suggest differential transport of large bird wings onto the site, but the albatross pedal phalanges/skull fragments suggest that large birds were being transported whole.

5.3.4 | Cormorants

Complete cormorant elements are dominated by femora and carpometacarpi; the latter are also frequently broken into proximal/distal halves (Figure S9). Cormorants are the only taxa to be represented by high numbers of axial elements (vertebrae). The dominance of vertebrae is puzzling; other meat-bearing elements are both poorly (sterna, furcula) and well-represented (coracoids) (Table S5). Perhaps cormorants were processed differently and/or the vertebral column was discarded more frequently than that of other species; we also note that high numbers of vertebrae suggest cormorants were

brought to the site whole. Cormorant elements also less frequently exhibit gnawing and cutmarks.

5.3.5 | Gulls

Gulls are represented by humeri, ulnae, and carpometacarpi and have similar element completeness proportions as cormorants (Figure S10) and similar element representation as geese/albatross, including smaller total % NISP of femora/tibiotarsi (Table S5). Ethnographically, gulls were not a preferred food, but they are the 4th most abundant taxa at Par-Tee. One gull ulna is charred, but very few exhibit cutmarks (NISP = 5) or gnawing (NISP = 4). Site inhabitants may have eaten gulls prior to contact, done so infrequently and/or opportunistically related to egg collection and offshore hunting for other animals, but we suggest based on wing bone representation that gull bones may also have been favored for tool manufacture.

5.3.6 | Summary

Limited analyses of bird bone artifacts (Losey, 2021) from Par-Tee and Palmrose suggest that differently sized bird bones, primarily from wings, were likely used for needle (Figure S11), whistle (Figure S12), and possibly tube bead manufacture. Bovy (2005, p. 155) reported evidence of "groove and snap" tool manufacture at the Minard site, but only one albatross bone in our Par-Tee sample exhibits possible signs of this technique, although more may be present in the unanalyzed bone tools.

Manufacture of artifacts from wing bones may explain the high fragmentation and general over-representation of wing, relative to leg bones, in the assemblage (Tables S5 and S6 and Figure S3), particularly the fragmentation of goose/gull/albatross ulnae and humeri; however, fragmentation of wings, especially the thinner radii, which could be lost through an excavation screen, cannot be ruled out. The instances of ulna/humerus hyperextension (Table S1) caused by site inhabitants wrenching the elbow joint are additional indications of wing removal at the distal humerus.

Humeri were the most abundant (Table 3) but least complete element across the entire assemblage (Figure S3), likely due to high fragmentation but potentially also due to dietary consumption. Following Funk et al. (2016, p. 386), humeri were left on the boiled chickens and also more likely to be damaged by chewing; perhaps humeri were additionally broken and fragmented as part of multiple steps in processing for dietary meat removal. Tibiotarsi were also badly fragmented throughout the site, again possibly due to dietary consumption (Funk et al., 2016) or as a result of their size. The presence of tarsometatarsi and other leg bones does, however, help to rule out dedicated differential transport of wings.

Only six specimens appear to be burned/charred (two Common Murres, one gull, one Short-tailed Albatross, and two scoters), but Oregon-specific sources suggest that birds and their eggs were likely boiled or baked (Jacobs, 2003, pp. 83, 76; Ames & Sobel, 2013, p. 135), which would not necessarily leave signs of cooking. Funk et al. (2016, p. 388) found that even grilling may not leave any or expected levels of burn marks/charring and therefore cannot be used to rule out anthropogenic cooking or burning.

With the exception of gulls (NISP = 422) and crows (NISP = 47), birds associated with ceremonial/symbolic roles and/or reported ethnographically to not be preferred foods (Ray, 1938; Zobel, 2002) are quite rare in the Par-Tee assemblage (e.g., only 12 Bald Eagle and five owl bones). These species may have been hunted infrequently, processed differently because of their significance, and/or deposited away from the main midden.

We suggest that the major taxa discussed here were all likely brought to the site whole and processed for dietary consumption and tool manufacture, but with additional considerations: we suggest that murres/scoters were processed for dietary consumption, with scoter bones also likely used for tool manufacture. Sooty Shearwaters were also processed with a focus on dietary consumption, followed by tool manufacture. Geese, albatross, and gulls were likely prioritized for tool manufacture as well as dietary consumption but, because of their size, may have been more heavily fragmented in the process. Cormorants were likely also used for dietary consumption/tool manufacture but, unlike the other taxa, were represented by large numbers of vertebrae, possibly suggesting a differential processing relative to other species.

6 | CONCLUSION

Analysis of over 7000 bird bones demonstrates that the Par-Tee avifaunal assemblage contains a wide range of birds from a variety of habitats, with people largely focusing on hunting or scavenging the most accessible and abundant species (scoters, murres, and shearwaters), either live or beached/wrecked in the adjacent quiet-water environment and nearshore habitat (see also Bovy et al., 2019). Par-Tee residents may also have collected gull eggs, gulls, and cormorants, ventured offshore to hunt pelagic species like albatross/shearwater, and targeted nearby kelp forests for efficient and/or opportunistic hunting of a wide variety of birds attracted to kelp forests. Although the Par-Tee site stratigraphic resolution is poor, the abundance of scoters, murres, and Sooty Shearwaters may suggest a year-round occupation. Birds were processed on site, likely for dietary consumption, artifact/tool manufacture, and use of feathers/down. Some species may have been more likely to be used for dietary consumption (e.g., murres and scoters) or tool manufacture (e.g., albatross, geese, and gulls) than others, but it is probable the major taxa each had multiple uses.

When placed in the context of other studies of the Par-Tee faunal remains, these data demonstrate the incredible variety of mammals (beavers, dolphins, whales, pinnipeds, sea otters, etc.), fishes (nearshore forage fishes), birds, and shellfish (cockles, clams, mussels, etc.) being collected and hunted by people living on the northern Oregon Coast during the Late Holocene (Colten, 2015; Loiselle, 2020; Losey & Power, 2005; Sanchez et al., 2020; Wellman et al., 2017).

The birds from Par-Tee add to this variety demonstrating further use of a range of coastal and other aquatic habitats for food, artifact production, and other aspects of people's daily lives and broader ritual and ceremony. With evidence for whaling, shellfish gathering, fishing, and extensive bird scavenging and hunting, the Late Holocene people at Par-Tee were clearly broad-scale foragers, with diverse subsistence strategies and in-depth environmental knowledge systems learned and passed down over millennia that have important insight for understanding contemporary environmental issues.

Our analysis also demonstrates the importance of legacy collections for understanding past environmental change and the interactions between people and birds, underscoring issues of sample size that may affect how researchers approach analyzing legacy faunal collections in light of time, budget, and other limitations (St. Amand et al., 2020). In the case of Par-Tee, the large size of the collection and previous analysis of a subsample by Colten (2015) enabled comparisons of both a smaller sample to the larger one we presented. The overall interpretations of major taxa of importance and habitats being exploited were similar between the smaller and larger samples. However, the identification of species that are never or only occasionally identified (e.g., California Condor) was considerably more robust in the larger sample. Consequently, when analyzing legacy faunal collections, subsampling strategies should carefully weigh the research questions being asked against budget and time limitations.

The large sample of bird bones we analyzed from Par-Tee includes some rare, at-risk species of present-day conservation concern like the California Condor, Marbled Murrelet, or Short-tailed Albatross. These species' bones were generally found in small numbers, prohibiting discussions of the abundance of these species in the local area, but they would be ideal for future analyses including ancient DNA and isotope analyses (Royle et al., 2022). Our research also documents the presence of some species, such as the Sooty Shearwater (the third most abundant taxa), that were previously unthreatened but may continue to face conservation challenges in the future (Carboneras et al., 2020b). Ultimately, future analyses of the Par-Tee and other Northwest Coast legacy assemblages, particularly genetic and isotope analyses, will prove crucial for helping understand human–environment interactions in the past and present, and help plan for future change. Such research will also help further justify the funding, space, and other concerns facing the curation of many legacy collections around the world.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Full species identifications and R code used for quantitative analyses are provided in Supplementary Information.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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