

ALEUTIAN ISLAND ALBATROSSES: A POPULATION HISTORY

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THREE species of albatross have frequented the seas near the Aleutian Islands during the Holocene; the Short-tailed Albatross (*Diomedea albatrus*), the Black-footed Albatross (*D. nigripes*), and the Laysan Albatross (*D. immutabilis*). Determining the population history of these albatrosses in the North Pacific has been beset by a host of problems. Two of these have been discussed in detail by Kenyon (1950), Sanger (1972a), and others; inaccuracies in visual reports and records, and changes in population density, frequency of occurrence, and geographical distribution of albatross species. Other problems include lack of attention paid to seasonal patterns of population distribution; lack of quantitative studies, such as of relative biomass of species; conflicting evidence in historical accounts and modern biological records with respect to species' nesting patterns; and lack of attention paid to archaeological representation and indicated patterns of prehistoric utilization of albatrosses in the Aleutian Islands. Archaeological remains can yield much information on prehistoric human diet, methods of faunal exploitation, cultural preferences in species utilization, and environmental changes. With this in mind, recent archaeological studies in the Aleutians are examined for their contribution to a more accurate reconstruction of albatross population history in the Aleutians and the North Pacific in general.

RECORDS OF LAYSAN AND BLACK-FOOTED ALBATROSSES

Kenyon (1950) succinctly pointed out some of the factors causing wrong identifications of North Pacific albatrosses in visual records. Among these was the fact that, prior to his studies, Laysan Albatrosses were believed to range only as far north as 40° N (Bent 1922), and hence rare individuals sighted north of that latitude (for example, in the Aleutian Islands, ca. 50–53° N) were likely to be misidentified as Short-tailed Albatrosses, common in that region before the late 1800's. Bent (1922: 9), in an earlier discussion of the distribution of Short-tailed Albatrosses, noted that records of this bird had been "confused with other species." Murie changed his mind about several albatrosses sighted in the Aleutians, which he at first recorded as Short-tailed, but later decided were Laysan Albatrosses (Kenyon 1950). In fact the first Laysan Albatross caught off the California coast in 1909 was at first reported to be a Short-tailed Albatross (Peters 1938). Short-tailed

Albatrosses were already greatly depleted by the 1920's (Anthony 1924), the majority eliminated by the activities of Japanese feather-hunters starting during the late 1800's and accelerating around the turn of the century under the auspices of the South Seas Trading Company (Austin 1949). Thus the confusion of records during the early 1900's must have been due to other factors than simply habituation to seeing Short-tailed Albatrosses. Certainly distinguishing these morphologically similar species is difficult at a distance, whatever their relative densities. In fact Laysan Albatrosses were not recognized as distinct from Short-tailed Albatrosses until 1893 (Austin 1949). Not only do adult Short-tailed Albatrosses resemble Laysan Albatrosses, but immature Short-tailed Albatrosses resemble Black-footed Albatrosses as well (Sanger 1972b). Still the possibility must be considered that the confusion of records was due to an increase in the Laysan's range, expanding into the niche vacated by the Short-tailed Albatross. Whether Bent (1922) was citing 40° N as a maximal or minimal northern range for the Laysan Albatross is not at all clear; it may in fact have been a mean figure, in which case substantial numbers of this species must have ventured farther north than 40°, at least at that time. If this was a maximal figure for the northerly range of the Laysan Albatross, then perhaps this was a statement valid for the time when Bent was writing, but has changed since. Kenyon indicated that in the 1950's the Laysan Albatross clearly ranged farther north than 40°, although it still did not "venture more than a few miles north of the Aleutian Chain" (Kenyon 1950). If this represented an expansion of the Laysan range, then it was in all likelihood an eastward as well as northward expansion, with more birds being sighted near the California coast (McHugh 1950). By the early 1960's, Laysan Albatrosses were reported as far north as 59°, although the Aleutians still generally formed the "northern boundary of their distribution" (Fisher and Fisher 1972). Finally, recent studies by Shuntov (1968, 1972) have shown that Laysan Albatrosses range far north of the latitude of the Aleutians, at least in the western Bering Sea. Nothing suggests that this might be due to increases or northward shifts in the primary productivity of the North Pacific Ocean. Although these reports may partly reflect increased accuracy of observation, the expansion of the Laysan Albatross into the vacated niche of the Short-tailed Albatross is the simplest explanation of the trend as a whole. If true, it should be indicated by larger numbers of Laysan Albatross remains in archaeological strata representing the last 100 years.

The Laysan Albatross was probably never very plentiful in the Aleutian Islands in the past. While it was not recognized as a distinct species until the 1890's, the total lack of records of this bird in the

Aleutians would lead one to expect little representation of the species in prehistoric middens. In addition, because the Laysan Albatross is rather shy and not given to following boats to the extent other albatrosses do, and because it tends to feed farther out to sea than the other species (Loomis 1918, Fisher 1972, Sanger 1974b), it would be expected to be underrepresented in midden samples in relation to its abundance in the ecosystem as a whole. Nevertheless as Kenyon (1950) indicated, the Laysan Albatross "occurs more frequently near (the) coast than the dearth of records now indicates." Therefore, if albatross remains were found in midden deposits in any sort of significant amounts, it would be doubtful that Laysan Albatrosses, if present in the ecosystem, would be totally unrepresented.

For the Black-footed Albatross Kenyon (1950) indicated that the Aleutian Islands fall in a "fringe area for the northern occurrence of this bird." While recent data (Kurochkin 1963; Shuntov 1968, 1972; Sanger 1974a; Robbins and Rice 1974) show that Black-footed Albatrosses do range northward during the summer, penetrating into the Bering Sea, the fact remains that "the Laysan Albatross during its migration period sticks to colder regions of the northern part of the Pacific Ocean, while the Black-footed sticks to warmer regions" (Shuntov 1972). The Laysan seems to prefer water temperatures of 7 to 14°C, while the Black-footed Albatross prefers water temperatures of 12 to 20°C (Shuntov 1972). Apparently this is due not so much to temperature tolerances per se as to interspecific competition among the albatrosses (Shuntov 1972). In fact, this competitive exclusion is partly responsible for the maintenance of morphological and behavioral differentiation of Black-footed and Laysan Albatrosses, the latter having diverged from original Black-footed stock (Fisher 1972).

On the basis of their distribution, one would expect Black-footed Albatrosses to be scantily represented in Aleutian midden samples, but because they are more gregarious than Laysan Albatrosses and tend to feed more in turbulent waters such as interisland passes (Miller 1940), one would expect their remains to be scattered throughout the middens in somewhat greater numbers than those of the Laysan.

RECORDS OF SHORT-TAILED ALBATROSSES

Short-tailed Albatrosses were recorded as "more or less numerous" by the earliest expeditions to the Aleutian Islands (Nelson 1887: 61). A prominent member of one of those expeditions was the naturalist Pallas (Masterson and Brower 1948), who failed to find any evidence of nesting albatrosses in the Aleutians. Subsequently Chamisso, a naturalist with von Kotzebue's 1817 expedition, verified Pallas' observa-

tions as to the abundance of albatrosses, but amended them with the observation that not only did Short-tailed Albatrosses nest in the Aleutians, particularly on Umnak Island and the Islands of the Four Mountains (ca. 168 to 170° W), but the Aleuts exploited their nests for both birds and eggs (Kotzebue 1821). Turner (1886: 128) also believed that the Short-tailed Albatross bred in the Aleutians, for an incorrect reason. He reported that "this bird breeds in some locality among the islands, for it is found there from the early part of May to late October," apparently unaware of the winter breeding season for albatrosses. Even if an albatross chick could have been hatched in the Aleutians at that time, it is doubtful that it could have been reared under the short summer conditions (Austin pers. comm.). Aleut folktales in contrast indicate that "albatross used to nest in small numbers on Bobrof Island, on top of the mountain, in winter" (Murie 1959: 35), an even less likely proposition. Dall (1872) believed that the Short-tailed Albatross "breeds in the islands, as we saw the mutilated carcass of a very young one, in August, at Atka." Considering that albatrosses take from 6 to 9 years to mature fully, and that some fledgling individuals are inevitably included in annual northward migrations, the presence of young birds is not in itself indicative of breeding status. The same argument applies to Spaulding's (1962: 121) claims for breeding status on the basis of "possibly some immature" albatross remains from archaeological excavations on Agattu Island. In addition it is impossible to determine whether or not fledgling birds were included among the "immatures." As the Short-tailed Albatross breeds on flat, open ground, it would have been rapidly eliminated from all but the most isolated islands. Kenyon (pers. comm.) suggests that early explorers confused the Short-tailed Albatross with the Northern Fulmar (*Fulmarus glacialis*), a smaller but morphologically and ecologically similar species (Brown 1970). The question that naturally arises is exactly how plentiful these two species were in precontact times, both in total densities and numbers relative to each other. This is a question archaeological data can help resolve.

Archaeological data can also help to reconstruct the past relative abundance of the three species of albatrosses themselves in the Aleutians. Because of the apparently great abundance of Short-tailed Albatrosses described in the early reports, one would expect their remains in the middens to far outnumber those of other albatrosses. The reports also indicated large numbers of these birds in the vicinity of the islands themselves; like Black-footed Albatrosses, they were apparently quite gregarious, Bent (1922: 8) noting that the Short-tailed Albatross "occasionally follows vessels for the purpose of picking up what scraps are

thrown overboard." It is logical to postulate that, like Black-footed Albatrosses, they fed in interisland passes. If they were predominantly exploited in these passes rather than on any hypothetical nesting ground, (1) few fledgling remains should be found in the middens, and (2) the frequency of albatross remains should vary little between archaeological sites in comparison with other species hunted on or near shore in localized areas.

At present albatrosses winter south of the Aleutians and occur near the islands in largest numbers during late summer and fall. Apparently their increased availability during this period reflects seasonal abundance of zooplankton in the North Pacific (Koblents-Mishke 1965), as zooplankton (auphausiids, crustaceans, and cephalopods) form the bulk of the albatross diet (Fisher and Fisher 1972). Increased availability of zooplankton in the late summer and fall follows close on the heels of increased primary productivity in the spring and early summer in the North Pacific, particularly the Aleutian coastal area (Larrance 1971). Shearwaters, like albatrosses, winter to the south, appear in the Aleutians during the late summer and fall, and feed on a variety of zooplankton predominantly in interisland passes, where they gather in huge numbers (Arnold 1948; Murie 1959: 41; Kuroda 1960; Kelley et al. 1971). A high correlation between shearwater and albatross remains in midden samples would probably indicate that these ecological similarities extended into the past, with large seasonal concentrations of Short-tailed Albatrosses being found in the Aleutians.

If these patterns hold true, then Short-tailed Albatrosses, being both physically large and seasonally reliable, must have been highly prized by the Aleuts, particularly at times when sea-mammal flesh, which generally contributed 100 times as many calories as bird flesh to the diet (Denniston 1972, Yesner MS), was unobtainable. Logically, one would expect that Short-tailed Albatrosses (1) were hunted in frequencies in excess of their biomass in the ecosystem as a whole, and (2) contributed more to the Aleut diet than did other birds.

OSTEOLOGY OF NORTH PACIFIC ALBATROSSES

To answer these questions, definite separability of the North Pacific albatrosses osteologically must be possible. Because no published osteometric analyses exist of intraspecific and age variation in these birds, comments will be largely confined to structural rather than size differences. Comparisons were based on four specimens each of Laysan and Black-footed Albatrosses, but only a single specimen of Short-tailed Albatross was available.



Fig. 1. Sterna of Black-footed (left) and Short-tailed Albatrosses in antero-ventral view.

A number of differences were found in the skeletal morphology of these three species. Some examples of these differences in archaeological specimens are depicted in Figs. 1 to 3. The most radically different of the specimens are the sterna of the Black-footed and Short-tailed Albatrosses (Fig. 1); several features serve to distinguish them, most notably the form of the carinal apex. This structure is broad and spatulate in the sternum of the Short-tailed Albatross, but narrow and parallel-sided with a pointed tip in the sternum of the Black-footed Albatross. Another feature differentiating the two sterna is the anterior carinal margin. While both are bifurcated by a raised bony midline, that of the Short-tailed Albatross bears a notable central depression and distinct lateral borders not present in that of the Black-footed Albatross. Also notable is the transverse manubrial groove, which is much broader with less concave margins. In the Black-footed Albatross, the bilateral portions of the coracoidal sulcus nearly meet at the midline, whereas they are clearly separate in the Short-tailed Albatross. Also, in the Short-tailed Albatross the coracoidal sulcus is much more deeply excavated.

The femora of these species (Fig. 2) differ both in size (Table 1) and in structure. The trochanter is larger and projects more, and the obtura-



Fig. 2. Femora of Short-tailed (left) and Black-footed Albatrosses in anterior view.

tor ridge is more rugose and projects more in the femur of the Short-tailed Albatross. The shaft of this femur is relatively wider and less concave, particularly in its medial portion. The greater excavation of the rotular groove can also be seen Fig. 2, although somewhat obscured by decay of the distal portion of the femur. The intercondylar breadth and total width of the distal end is greater in the Short-tailed Albatross, but the depth of the popliteal area is relatively greater in the Black-footed Albatross. The internal condyle is larger and more spatulate in shape (in posterior view) in the Black-footed Albatross, but the external and fibular condyles diverge more in the Short-tailed Albatross, with greater posterior extension of the fibular condyle.

The skeletal remains of the Short-tailed Albatross differ more clearly in size and structure from those of the Laysan Albatross. Carpometa-

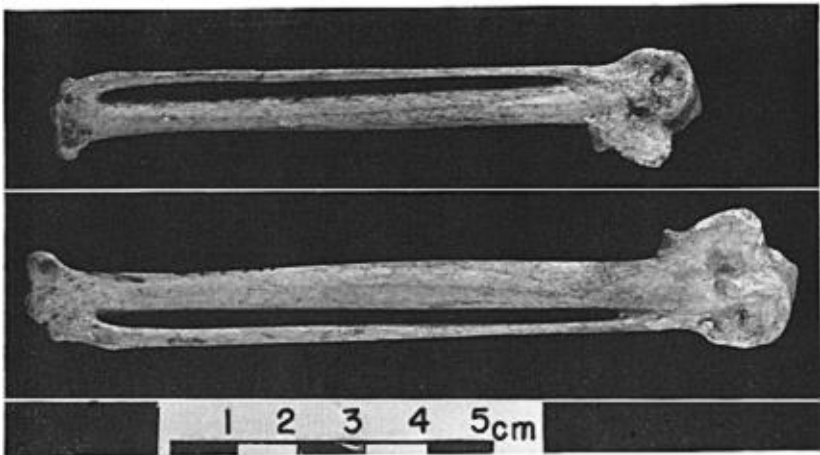


Fig. 3. Carpometacarpals of Laysan (top) and Short-tailed Albatrosses.

carpals of these two species are illustrated in Fig. 3. The degree of size difference exhibited (Table 1) cannot be attributed to sexual dimorphism, which is insubstantial in albatrosses, particularly the Laysan Albatross, which can only be sexed with 23% certainty on the basis of biometrics (Frings and Frings 1961). While sexual dimorphism is in general more pronounced in head and bill sizes in the Short-tailed and Black-footed Albatrosses (Frings and Frings 1961), it is generally very slight in wing lengths (Loomis 1918: 73), and hence would affect carpometacarpal lengths very little if at all. Nor can this size difference be attributed to age, as no archaeological specimens were from fledglings or "young birds," i.e. those less than 3 years of age (Fisher and Fisher 1972). So far as the specimens depicted are concerned, the tuberosity of metacarpal II, facets for fused digits II/III, and ligamental attachment of the pisiform process are much more developed in the carpometacarpus of the Short-tailed Albatross.

Other major distinguishing features were noted on coracoids and humeri. In general I have encountered no insurmountable difficulties in dis-

TABLE 1
COMPARATIVE OSTOMETRY OF ALEUTIAN ALBATROSS SPECIMENS

	<i>Diomedea albatrus</i>	<i>Diomedea nigripes</i>	<i>Diomedea immutabilis</i>
Carpometacarpus	10.40 cm	—	8.53 cm
Digit III, phal. I	4.12 cm	3.99 cm	—
Femur	7.48 cm	6.37 cm	—

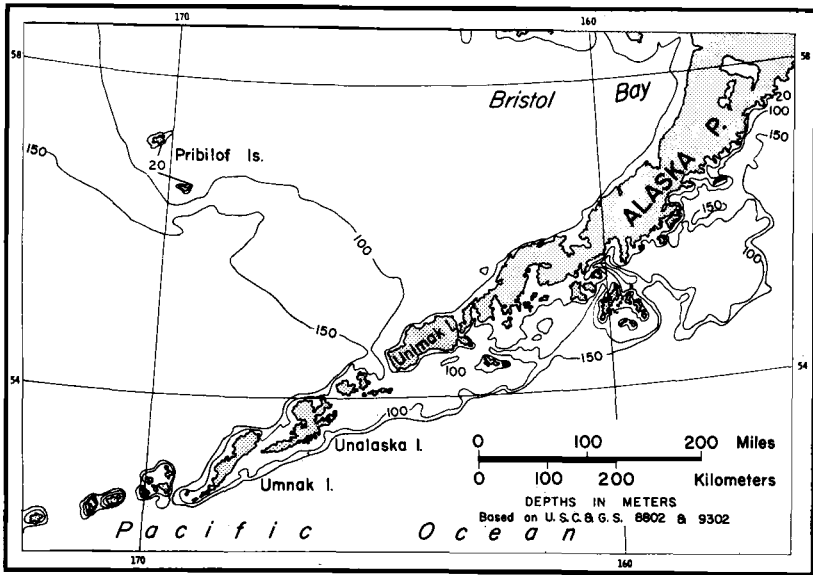


Fig. 4. The eastern Aleutian Islands and Alaska Peninsula.

tinguishing between the three albatross skeletons from archaeological remains.

ARCHAEOLOGICAL REPRESENTATION OF SHORT-TAILED ALBATROSSES

The avian data discussed here were derived from analysis of four archaeological sites on southwestern Umnak Island in the Aleutians (see Fig. 4 for the position of Umnak Island in the Aleutians and Fig. 5 for a map of the southwest Umnak archaeological sites). These sites were excavated by the Departments of Biocultural Anthropology and Biobehavioral Sciences of the University of Connecticut during the summers of 1970, 1971, 1972, and 1973. Sites sampled ranged from cliff top sites without fishing streams or extensive reefs, where birds were of relatively greater dietary importance (e.g. the Anangula Village site), to lower level mounds associated with fishing streams and extensive reefs, where birds were of relatively lesser dietary importance (e.g. the Chaluka site).

Because of vagaries of sample size, the exact figure for the abundance of various bird species in these sites depends on whether one relies upon total numbers of bones or uses minimum numbers of individuals reconstructed from the skeletal remains of a given stratigraphic unit (Grayson 1973) in calculating frequencies. While minimum numbers of in-

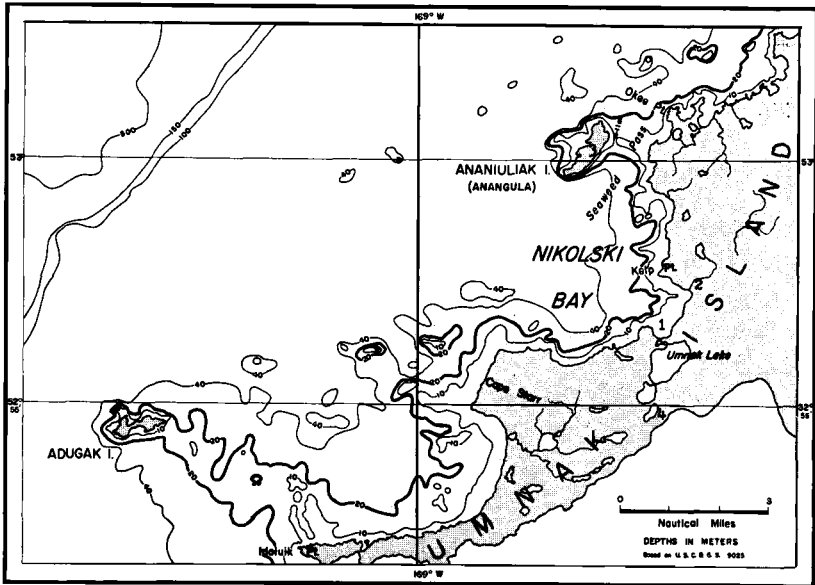


Fig. 5. Archaeological sites on southwest Umnak Island, Aleutian Islands. 1, Chaluka; 2, Sheep Creek; 3, Anangula Village; 4, Oglodax'.

dividuals (hereinafter referred to as "MNIs") may reflect more accurately the relative importance of the different taxa exploited at different time periods, they may also distort faunal frequencies when dealing with small sample sizes by exaggerating the importance of rarer taxa. The distortion is generally not so great for birds as for mammals, probably because of smaller interspecific range in body size. Because of this, and high correlations between total bone counts and MNIs in the southwest Umnak data, MNIs have been employed here in calculating species frequencies.¹

Archaeological biomass data were obtained from the product of MNIs and bird weights, the latter derived mostly from Palmer (1962) and Poole (1938). Where seasonal weight differences existed, were recorded, and were applicable to the period of residency of a given Aleutian species, weights were averaged out over the appropriate period. Archaeological data were then compared with biomass data for birds in the modern ecosystem, derived from the product of bird weights and seasonally averaged species "abundance scores" based on Aleutian National Wild-

¹The computer program used to calculate MNIs and species frequencies scans a matrix containing data on species, sex, age, skeletal element, and side of the body for all faunal materials. Copies of this program are available on request.

TABLE 2
COMPARATIVE ARCHAEOLOGICAL AND BIOLOGICAL AVIAN BIOMASS DATA

Species	Biological biomass rank	Archaeological biomass data				Mean rank
		Chaluka	Oglodax'	Anangula Village	Sheep Creek	
<i>Phalacrocorax pelagicus</i>	1	7	4	5	1	3
<i>Larus glaucescens</i>	2	10	9	8	7	5
<i>Uria</i> spp.	3/4	3	13	9	10	6
<i>Lunda cirrhata</i>	5	8	14	15	9	8
<i>Fulmarus glacialis</i>	6	9	2	1	19	4
<i>Anas crecca</i>	7	—	—	—	22	23
<i>Diomedea albatrus</i>	8	2	3	3	5	1
<i>Haliaeetus leucocephalus</i>	9	5	6	—	6	9
<i>Histrionicus histrionicus</i>	10	20	17	—	21	16
<i>Rissa tridactyla</i>	11	—	25	22	—	20
<i>Gavia immer</i>	12	16	10	10	16	10
<i>Somateria mollissima</i>	13	13	8	7	8	7
<i>Phalacrocorax urile</i>	14	4	7	2	2	2
Misc. Alcidae	15	14	21	12	15	13
<i>Gavia stellata</i>	16	23	18	20	—	17
<i>Anas platyrhynchos</i>	17	—	—	23	—	24
<i>Corvus corax</i>	18	19	16	24	20	15
<i>Falco peregrinus</i>	19	—	24	—	25	21
<i>Haematopus bachmani</i>	20	—	29	21	—	22
<i>Olor</i> spp.	21	12	5	—	11	12
<i>Phalacrocorax auritus</i>	22	21	11	11	4	9
<i>Phalacrocorax auritus</i>	23	11	23	6	—	14
<i>Somateria spectabilis</i>	24	15	12	13	13	11
<i>Mergus merganser</i>	25	27	28	14	—	18
<i>Branta nigricans</i>	26	29	24	19	—	19

life Refuge reports (Yesner MS).² The results of these calculations (Table 2) show that Northern Fulmars were both highly abundant and highly exploited, with a rank of 6 in modern and 4 in archaeological biomass data. The ubiquitousness of Northern Fulmars renders unlikely the possibility that Chamisso erred in his identifications of albatrosses as suggested by Kenyon. Nevertheless, out of nearly 400 albatross remains recovered from southwest Umnak Island, no remains were found of fledgling or "very young" individuals. While this does not directly refute Chamisso's claims of Short-tailed Albatross nesting in the Aleutians, it at least renders improbable that Aleuts obtained albatrosses on

²National Wildlife Refuge qualitative coding of seasonal species abundance ("abundant," "common," "occasional," "unusual," and "rare") was transformed into relative orders of magnitude (10^2 , 10^1 , 10^0 , 10^{-1} , and 10^{-2} , respectively) and averaged over the four seasons before multiplying by average species weights. This method was in part derived and modified from Fay and Cade (1959). For qualitative codings of species abundance see U.S. Fish Wildl. Serv. (1969); quantitative estimates of summer and winter abundance based on shipboard censuses are from Sanger (1972b).

TABLE 3
ABUNDANCE OF ALBATROSS REMAINS IN SOUTHWEST UNMAK MIDDENS

Archaeological site	Total bones	Albatross bones (N)	Albatross bones (%)	Total MNIs	Albatross MNIs	Albatross MNIs (%)
Oglodax'	2084	144	6.91%	586	27	4.61%
Chaluka (west)	3133	125	4.00%	860	34	3.95%
Chaluka (east)	852	68	7.98%	203	22	10.84%
Anangula Village	369	35	9.48%	133	10	7.52%
Sheep Creek	319	14	4.39%	125	5	4.00%
ALL SITES	6757	386	5.71%	1907	98	5.14%

nesting grounds, particularly considering the unlikelihood of survival of exploited nesting areas (Austin pers. comm.).

In addition, frequencies of albatross remains, better than 95% of which were of Short-tailed Albatrosses, were remarkably similar in different sites, ranging from ca. 4.0 to 10.8% (Table 3). In fact, there was less variance in intersite albatross frequencies than for any other family of birds utilized by the Aleuts (Table 4). Using six pairwise intersite comparisons to calculate χ^2 values, albatrosses were demonstrated to be the only avian family whose mean frequency differed so little between sites as to be insignificant at the 0.01 level. This further substantiates the hypothesis that albatrosses were hunted offshore, with all villages equally likely to serve as home bases for such activities, irrespective of microenvironmental differences that would have affected the hunting of other species.

In all likelihood Aleuts hunted Short-tailed Albatrosses in the past as an adjunct to other activities such as marine fishing or sea-mammal hunting in the bays and passes near village sites. They were probably not the subject of a specialized hunt; more than likely they were obtained either as they followed boats or as boats came upon them in

TABLE 4
INTERSITE COMPARISON OF AVIAN FAUNAL FREQUENCIES

	Dio- medeidae	Procel- lariidae	Phalacro- coracidae	Anatidae	Laridae	Alcidae
N (bones)	387	3139	626	691	290	1593
\bar{x} (%)	6.62	39.30	14.06	9.76	3.86	20.61
V	4.14	396.48	63.85	40.88	6.75	424.94
SD	\pm 2.04	\pm 19.91	\pm 7.99	\pm 6.39	\pm 2.60	\pm 20.61
SE (\bar{x})	\pm 0.91	\pm 8.91	\pm 3.57	\pm 2.86	\pm 1.16	\pm 9.26
χ^2 (5 df)	16.13	147.54	67.44	87.75	51.01	437.60

waters where they congregated (particularly if other hunting activities were unproductive). It is reasonable to suppose that Short-tailed Albatrosses were formerly found in great numbers in such places as Samalga Pass between southwest Umnak Island and the Islands of the Four Mountains, the site of a major nutrient-rich vertical upwelling system, associated with high densities of plankton and other marine life (Kelley et al. 1971). Village sites in the southwest Umnak region would have been particularly favorable locations for obtaining albatross. Archaeological sites on Akun Island farther to the east, located near an even stronger upwelling system, exhibit even higher frequencies of albatross remains (Turner and Yesner MS). In these places albatrosses may have been hunted with darts or spears (Kotzebue 1821), nets (Veniaminov 1840, Hrdlicka 1945), or snares (Veniaminov 1840, Jochelson 1933). Only the first of these are known ethnographically to have been used in hunting albatrosses as opposed to other seabirds. Dart points have been found archaeologically (Denniston 1966), as have bolas, which may well have been used in hunting these birds (cf. Nelson 1969: 158 for their method of use). Finally, hooks may have been used, even though none have been recovered archaeologically (they may have been made of driftwood), as they were the predominant means of catching albatross by the Maoris of New Zealand (Buck 1950: 99), and have been found at archaeological sites in North Otago, New Zealand (Trotter 1965). Furthermore, albatrosses have frequently been caught off the Aleutians from ships by use of a baited hook and line (Bent 1922: 8; Robbins and Rice 1974).

The probability that Short-tailed Albatrosses were hunted in inter-island passes is lent further credence by the higher degree of correlation found between frequencies of albatross and shearwater remains than between either and any other bird remains in the southwest Umnak sites (Table 5). In addition, this indicates that the seasonal abundance of albatrosses in the Aleutian area may well have extended into the past. Not surprisingly, therefore, Short-tailed Albatrosses were one of the most popular birds in all sites (Table 2), along with the cormorants. As ethnographic evidence (Veniaminov 1840, Jochelson 1933) indicates that cormorants were used more for making feather parkas than for food, it is likely that these figures underestimate the total dietary importance of albatrosses. In actuality, they were probably the most important avian food source, particularly in times of dietary stress. In fact Short-tailed Albatrosses form the upper end of an apparent Aleut subsistence strategy whereby very large birds were relied upon even if generally sparse in the ecosystem as a whole, while (at the other end of

TABLE 5

CORRELATIONS BETWEEN AVIAN FREQUENCIES FOR SOUTHWEST UMNAK SITES

	Diome- deidae	Procel- lariidae	Phalacro- coracidae	Anatidae	Laridae	Alcidae (large)	Alcidae (small)
Diomedidae	1.0000	0.3045	0.1298	0.1598	0.1243	-0.3221	-0.1445
Procellariidae	0.3045	1.0000	-0.1916	-0.0244	-0.0476	-0.2085	-0.1996

continuum) very small birds were hunted only if present in very high densities. By this means an optimal range of bird biomass was exploited by the Aleuts, insuring an effective return on energy invested.

Logically the question arises as to how the dietary importance of these birds compared with their biomass in the ecosystem as a whole. As the Short-tailed Albatross population has been greatly depleted without being replaced in anything like equal numbers by other albatrosses, modern figures of albatross biomass underestimate the prehistoric situation. If instead the sum of the biomass figures for the Black-footed and Laysan Albatrosses based upon weight data from Fisher (1967) is used as a minimal comparative figure for the former abundance of all albatrosses in the Aleutians, albatrosses ranked eighth in total biomass in the ecosystem (Table 2). While this procedure may still underestimate the former abundance of Short-tailed Albatrosses to some extent, it is probable that their dietary importance did exceed their average density.

ARCHAEOLOGICAL REPRESENTATION OF BLACK-FOOTED AND LAYSAN ALBATROSSES

Of all the avian remains from the southwest Umnak sites, only a dozen specimens of the Black-footed Albatross have been recovered, and only half that number of the Laysan Albatross. The specimens of the Black-footed Albatross, while few in number, were distributed throughout the middens in which they have been found (the Chaluka and Oglodax' sites). With full realization of the sample size, it still seems most reasonable to argue that the Black-footed Albatross was, in the past as now, less plentiful in the Aleutians and of a generally more southerly distribution. Perhaps competitive exclusion by the Short-tailed Albatross was an additional factor operating in the past. The situation is different for the Laysan Albatross. While there are fewer remains of this bird, they have all been found within the uppermost strata of the middens (again, the Chaluka and Oglodax' sites), radiocarbon dated to within the last 200 years and associated with historic artifacts datable to within the last 100 years. Again, with all due respect to the sample size, archaeological remains seem to indicate that, while the Black-footed Albatross has re-

mained stable in its niche, the Laysan Albatross has to some extent re-occupied the niche vacated by the Short-tailed Albatross. A divergent evolutionary history on the part of the two species may well have produced biological factors impeding greater numbers of Laysan Albatrosses from expanding into the Short-tailed Albatross niche, resulting only in a certain amount of range adjustment. If this is indeed the case, it helps to explain some of the recently increased northerly and easterly sightings of Laysan Albatrosses.

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SUMMARY

Three species of albatross have frequented seas near the Aleutian Islands during the Holocene: the Short-tailed Albatross (*Diomedea albatrus*), Black-footed Albatross (*D. nigripes*), and Laysan Albatross (*D. immutabilis*). Determining the population history of these birds in the North Pacific has been beset by many difficulties, including inaccurate visual reports, conflicting evidence on species nesting patterns, changes in species distribution, and lack of quantitative data on relative species abundance. Archaeological data from several site excavations on southwest Umnak Island in the Aleutians demonstrate that albatrosses were a major contributor to the avian portion of the prehistoric Aleut diet. As a large and seasonally reliable resource, they were probably particularly important in times of dietary stress. The abundance of albatross remains in archaeological sites, lack of very young individuals, intersite homogeneity of albatross frequencies, and correlation between albatross and shearwater frequencies suggest that albatrosses were hunted at sea, in all probability where they congregated in nutrient-rich upwelling waters in interisland passes, and while following boats engaged in other hunting activities. Most of the albatross remains recovered were of Short-tailed Albatrosses, probably indicating the greater abundance and near island distribution of this species. Black-footed Albatross remains were fewer in number and scattered throughout the mid-

dens, probably reflecting the generally more southerly occurrence of this species, and possible competitive exclusion by Short-tailed Albatrosses. Laysan Albatross remains were restricted to the upper levels of all sites, possibly indicating that increased reports of this bird are due to expansion into the niche formerly occupied by the Short-tailed Albatross.

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