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SPECIAL ISSUE PAPER

Processing Activities and Differentiation of Bird Utilization During the Late Holocene in the Beagle Channel Region (Southern South America)

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ABSTRACT Recent research into prehistoric subsistence among the sea nomad societies of the Beagle Channel region of southern South America have shown that there were temporal changes in the utilization of animal resources between the Middle and the Late Holocene. A relative increase in the utilization of fish and birds has been noted in the Late Holocene, together with changes in the selection of bird and fish taxa. The most important change was the appearance of sites in high topographic locations where special activities were recorded that were related to the intensive exploitation of Phalacrocoracidae and the increase in the utilization of Procellariiformes.

In this paper, we examine the characteristics of these later assemblages in order to explore possible explanations for the changes in the use of birds. The cut marks on the bones were distinguished in order to differentiate the activities involved. The results indicate that in the Late Holocene there was no differential pattern of cormorant butchering between those sites where special tasks took place and general activity sites. It was also shown that the increase in Procellariiformes was linked mainly to subsistence rather than technological factors. Copyright © 2013 John Wiley & Sons, Ltd.

Key words: bird use; Beagle Channel; Late Holocene; Phalacrocoracidae; Procellariiformes; cut marks

Introduction and goals

The Beagle Channel region is located at the southern extreme of South America in the Subantarctic Area (Figure 1). This region was inhabited by hunter–gatherer societies that developed a littoral specialization from at least 6400 years BP and which continued up to the 19th century. There is evidence for the exploitation of littoral and marine resources and the development of specialized technology for their capture (Orquera & Piana, 1999a, 2005, 2006, 2007, 2009; Orquera, 2005). Pinnipeds are considered to be the main resource from a nutritional point of view, while resources with low individual return rates, such as mussels, fish and birds, have been considered to be dietary supplements that provided flexibility in the subsistence. However, recent studies have suggested that the role of low-ranked prey, especially birds and fish, was more complex and variable than was previously assumed (Juan-Muns i Plans, 1996; Zangrando, 2003, 2007, 2009a, 2009b; Mameli & Estévez Escalera, 2004; Tivoli, 2010a, 2010b, 2010c, 2012; Tivoli & Zangrando, 2011).

Comparative studies between zooarchaeological assemblages of the Middle and Late Holocene have pointed out temporal changes in the utilization of bird resources by hunter–gatherers of the Beagle Channel region (Tivoli, 2010a, 2010b, 2010c, 2012). In the early period (*ca*. 6400–4000 BP), the exploitation of birds was focused mainly on members of the cormorant and penguin families (Phalacrocoracidae and Spheniscidae). In the Late Holocene (*ca*. 1500–100

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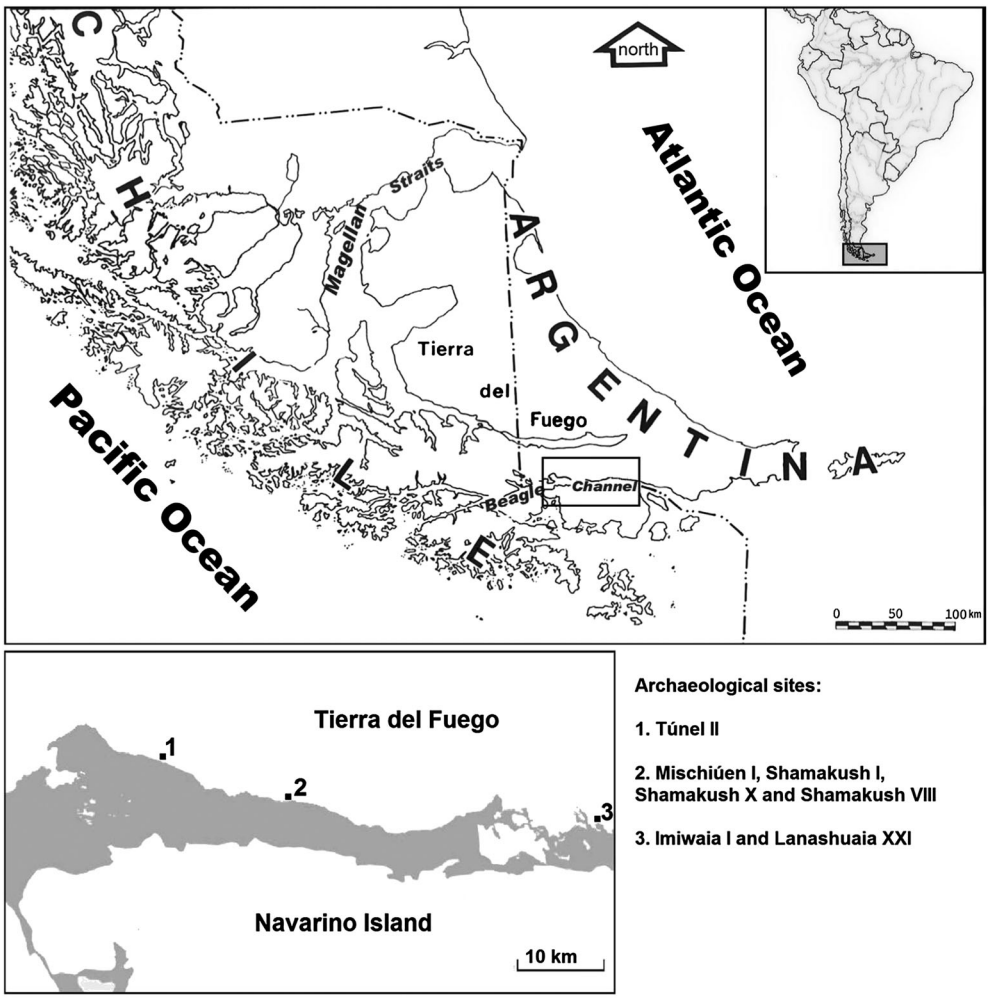

Figure 1. Map of the Beagle Channel region and location of sites discussed.

BP), there were four main trends in bird utilization (Tivoli, 2010a, 2010b, 2010c, 2012):

(1) there was an increase in the proportion of birds, measured by per cent NISP;
(2) there was a decrease in the exploitation of Spheniscidae;
(3) there was an increase in the selection of Procellariiformes (albatrosses, petrels and shearwaters); and
(4) there are some sites with large concentrations of Phalacrocoracidae that are thought to be locations for their intensive exploitation.

The shell midden sites accumulated as a result of daily activities and many of the bone remains from the middens have been interpreted as deriving from subsistence activities, based on the evidence of cut marks and the systematic selection of the same species (Serjeantson, 2009). This was also the case in the Magellanic region and the archipelago of Cape Horn (Lefèvre, 1989, 1993–94, 1997; Lefèvre *et al.*, 2003). Additionally, some technological tasks took place so some bones could have been discarded following these activities. This study aims to differentiate between these activities, mainly through the analysis of cut marks (Binford, 1981; Lyman, 1987, 1994; Fisher, 1995; Laroulandie, 2000, 2001, 2005a, 2005b; Serjeantson, 2009).

The bird families exploited in the Beagle Channel region in prehistory include the cormorants (Phalacrocoracidae), penguins (Spheniscidae), ducks and geese (Anatidae), albatrosses (Diomedeidae), petrels, shearwaters and fulmars (Procellariidae). Other birds appear in the zooarchaeological record, but in low numbers: Ardeidae, Accipitridae, Falconidae and Laridae. As pointed out, the early assemblages of the archaeological sequence were dominated by Phalacrocoracidae and Spheniscidae, with additionally intermediate numbers of Anatidae, especially

at the Imiwaia I site. In the later period, there was a decrease in Spheniscidae and an increase in the exploitation of Diomedeidae and Procellariidae. There is also a correlation between the increase in birds and the increase in fish in the Late Holocene and a concomitant relative decline in pinnipeds. Additionally, during the Late Holocene, some sites with a high concentration of cormorant remains have been recorded.

The aim of this paper is to examine the utilization of birds during the Late Holocene in the region. There are two main goals: first, to discuss possible explanations for the dominance of Phalacrocoracidae remains at certain sites; and second, to assess the implications of the increase in the utilization of Procellariiformes.

Exploitation of Phalacrocoracidae in Late Holocene times

Cormorant remains have been found in nearly all the zooarchaeological assemblages in the Beagle Channel region. In many cases, the NISP is higher than the NISP of other birds in both the Mid and Late Holocene (Figure 2) (Orquera & Piana, 1999a; Mameli & Estévez Escalera, 2004; Tivoli, 2010a, 2010b, 2010c). The representation of cormorants was more or less stable throughout the archaeological sequence, but in the Late Holocene only, there are some assemblages with high densities of bird bone consisting almost entirely of this taxa. The sites include Túnel II and Lanashuaia XXI (Piana & Canale, 1993–94; Álvarez *et al.*, 2013) and also the assemblages from Shamakush VIII which is still under analysis (Piana & Vázquez, 2009). It has been proposed that these are sites where 'special activities' linked to the intensive exploitation of cormorants took place. They are fairly small shell middens placed on high topographic locations or cliffs and they have less faunal and technological diversity in comparison to the sites that are considered to be 'general activity sites'. The latter are distinguished by: the presence of other animal resources – pinnipeds, guanacos and fish – in higher proportions and a greater taxonomic diversity of bird remains. These latter sites also have a higher diversity in the lithic and bone technology, are located mainly near the shore and were re-occupied several times. Examples of this last kind of assemblages are Imiwaia I, Mischiúen I, Shamakush I and X. This paper will investigate whether the different types of occupation imply distinctive uses of cormorants as a resource.

Based on ethnographic and archaeological information, it is known that cormorants were exploited for diverse purposes by hunter–gatherers in the Beagle Channel region (Orquera & Piana, 1999b). The use of cormorants in the subsistence sphere has been discussed in previous papers (Piana & Canale, 1993–94; Mameli & Estevez Escalera, 2004; Tivoli, 2010a, 2010b, 2010c, 2012). The use of bones as a technological raw material can be seen in the utilization of wing bones to manufacture awls, mostly on the humerus (Scheinsohn *et al.*, 1992; Orquera & Piana, 1999a; Scheinsohn, 2010; Tivoli, In press). The ethnographic record also shows that feathers were used for fletching arrows (Hyades & Deniker, 1891: 300; Gusinde, 1986: 452; Orquera & Piana, 1999b: 222). The use of cormorant skins for making coats is also referred to (Bridges, 1869: 116; Hyades & Deniker, 1891; Gusinde, 1951: 217, 1986: 390; Orquera & Piana, 1999b: 298). Many ornamental beads have also been found in archaeological assemblages. They were manufactured basically from the ulna and the radius

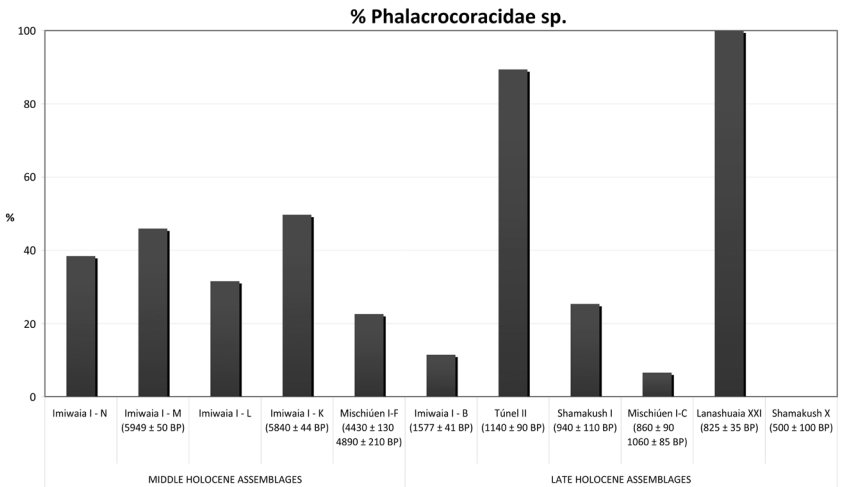

Figure 2. Percent NISP of Phalacrocoracidae in relation the total NISP of birds in Middle and Late Holocene assemblages.

and some were decorated (Orquera & Piana, 1999a; Fiore, 2011; see also ethnographic references: Fitz-Roy, 1839: 138–139; Bove, 1883: 126; Lovisato, 1883: 199, 1884: 139; Hyades & Deniker, 1891: 349; Martial, 1888: 188; Lothrop, 1928: 125; Gusinde, 1986: 419, 1445; Orquera & Piana, 1999b: 319–320).

These different uses of birds as a resource involved variable ways of processing and butchering the birds and in each case certain types of bone modification may be expected, particularly as expressed by cut marks (Lyman, 1987, 1994; Fisher, 1995; Laroulandie, 2000, 2001, 2005a, 2005b; Steadman *et al.*, 2002; Serjeantson, 2009). In order to explore the utilization of cormorants, the types of activities involved have been differentiated through analysis of the cut marks.

(1) In the activities involving only the procurement and use of feathers, the expectation is that cut marks will not be very frequent and evidence of dismembering or filleting will be lacking (Serjeantson, 2002, 2009; Laroulandie, 2005a). In the archaeological context, the anatomical regions of the cormorant skeleton will be found articulated or semi-articulated.
(2) Where cormorants were processed for the exclusive purpose of getting the bones for technology (awls) or ornamentation (beads), we would expect a low intensity of carcass butchery and a reduced frequency of cut marks (Serjeantson, 2009). The cut marks would mostly be located on specific anatomical units (the wing bones and coracoids), and fewer would be found on other anatomical parts. Additionally, there would be relatively fewer wing bones in the zooarchaeological record and/or artifacts would be present. Artifacts, however, might also have been taken to other locations.
(3) If the cormorants were captured to obtain the skin, we would expect to find cut marks mainly on the mandibles (Binford, 1981; Lyman, 1994; Serjeantson, 2009).
(4) Where cormorants were utilized for food, the bones would be disarticulated. Since complete carcass would have been introduced to sites, we would expect that all or nearly all skeletal elements would be represented in the bone assemblages. We would also expect many cut marks on different anatomical units, as evidence of dismembering or filleting (Laroulandie, 2000, 2001, 2005a). It should be noted that the pattern of marks related to food production and consumption can mask evidence for processing carried out for technological or ornamental purposes. In this case, the latter activity could not be discounted.

To analyze the frequency of cut-marked bones of cormorant, the NISP and the number of cut marked bones of cormorants is set out (Table 1).

The two special activity sites related to the use of cormorants, Túnel II and Lanashuaia XXI, show proportions of cut-marked bones within the observed range of the rest of the sites studied. This suggests that there are no great differences in the intensity of butchering of carcasses between sites with high accumulations of cormorant remains and sites with more diverse bird and other animal resources.

The anatomical profiles of the cormorant assemblages, measured by means of per cent MAU, show that there is no differential pattern between anatomical representations at the special activity sites (Túnel II and Lanashuaia XXI, shown in Figure 3b), and the general activity sites (Imiwaia I, B, Mischiúen I and Shamakush I, shown in Figure 3a): the anatomical composition of both types of assemblages seems to be similar. There are also no contrasts in the degree of articulation of the cormorant skeletons. It is therefore not possible to confirm that formation processes differed between these two types of site.

When the incidence of cut marks on cormorant bones is analyzed by anatomical category, there is also no apparent difference between the two groups of sites (Figure 4). Overall, there is a greater predominance of wing bones with cut marks, except at Imiwaia I, B, where no cut marks were seen on these bones. Most are on the humerus; there are fewer on the elements of the leg and the axial skeleton. The skull has the fewest cut marks in all the sites. However, it should

Table 1. NISP, MNI and number of cut marked bones of Phalacrocoracidae in Late Holocene assemblages: the sites are distinguished between special activity sites and general activity sites

	Site / Assemblage	Radiocarbon dates (years BP)	NISP of Phalacrocoracidae sp.	MNI of Phalacrocoracidae sp.	n cut-marked specimens
Sites of special activities	Túnel II	1140 ± 90	975	20	78
	Lanashuaia XXI	825 ± 35	111	3	4
Sites of general activities	Imiwaia I (layer B)	1577 ± 41	43	4	2
	Mischiúen (layer C)	860 ± 90 1060 ± 85	92	6	3
	Shamakush I	940 ± 110	85	3	14

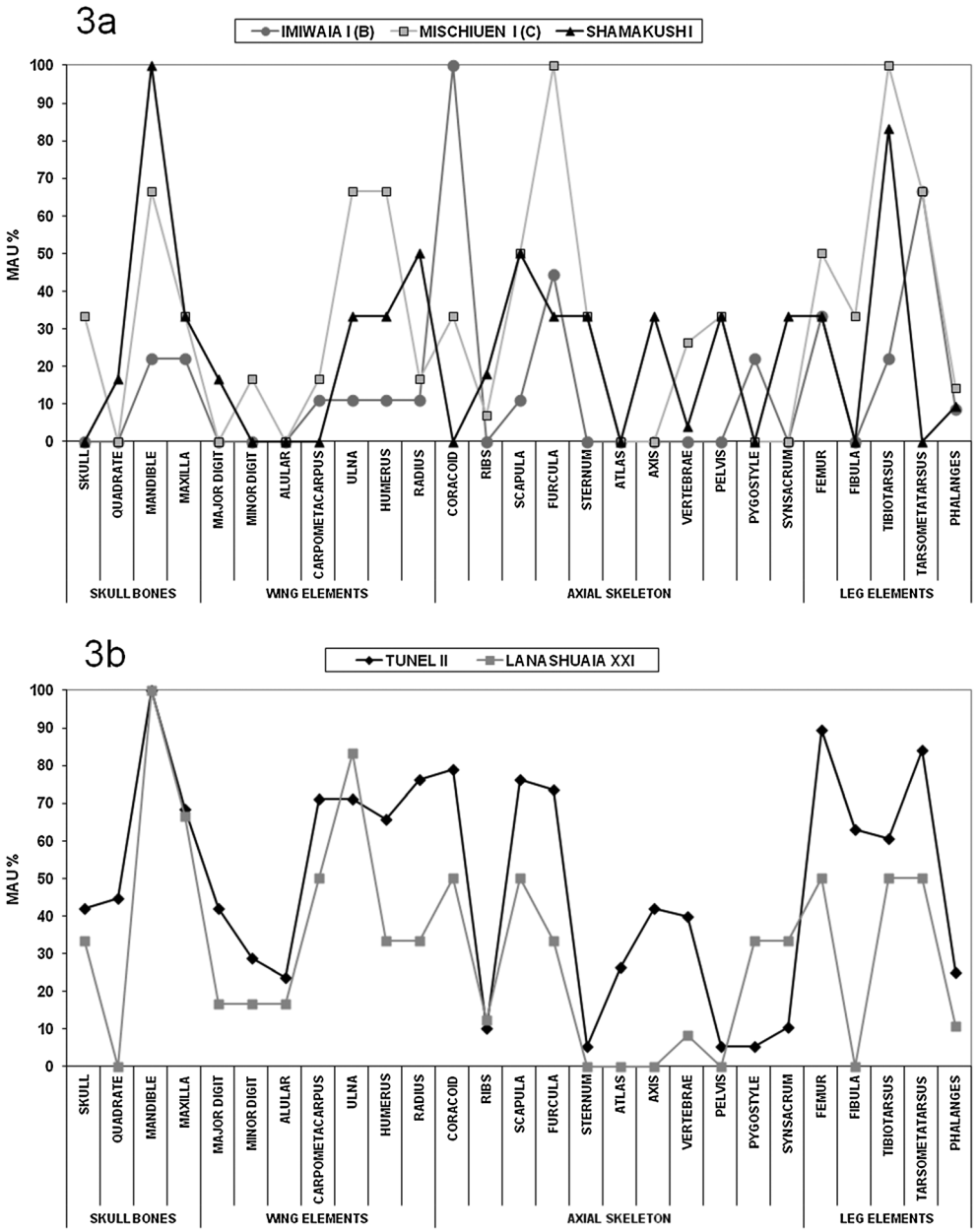

Figure 3. Anatomical parts representation (MAU %) of Phalacrocoracidae: 3a (top) Imiwaia I (layer B), Mischiúen I (layer C) and Shamakush I; 3b (below) Túnel II and Lanashuaia XXI.

be noted that the total number of bones with these anthropic marks is quite low.

The use of Procellariiformes in the Late Holocene

Procellariiformes were exploited for technological purposes and for subsistence in both the Mid and Late Holocene (Scheinsohn *et al.*, 1992; Rasmussen *et al.*, 1994; Orquera & Piana, 1999a; Mameli & Estévez Escalera, 2004; Piana *et al.*, 2007; Scheinsohn, 2010; Tivoli, In press). Previous papers have shown that there was an increased number of these birds in the zooarchaeological assemblages of the Late Holocene (Tivoli, 2010a, 2010b, 2010c, 2012; Tivoli & Zangrando, 2011). The implications of this increase in Procellariiformes in the prey of the hunter–gatherers of the Beagle Channel region in the Late Holocene are now examined. Three hypothetical scenarios are explored.

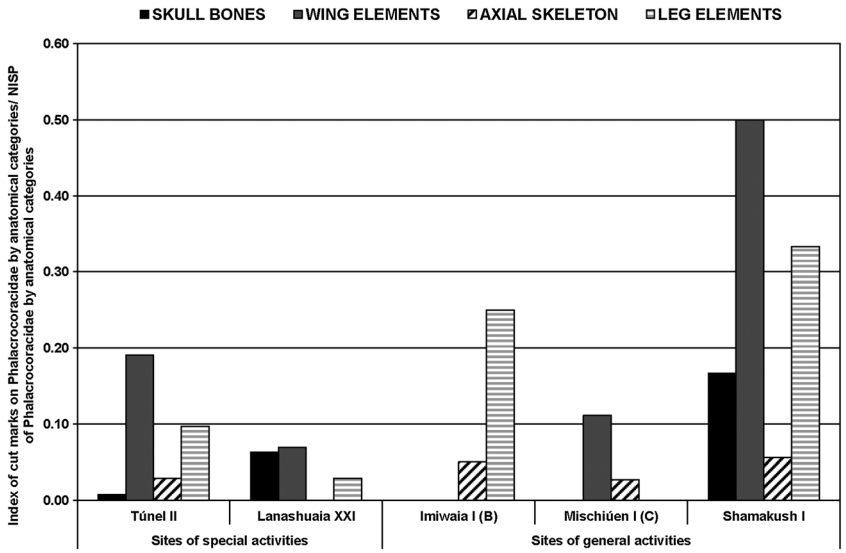

Figure 4. Proportions of cut marked bones of Phalacrocoracidae according to anatomical categories.

(1) First, if the increase in this resource was mainly due to technological needs, we would expect a higher proportion of awls produced on the humerus and also a low intensity of carcass butchery and a reduced proportion of cut marks (Laroulandie, 2000, 2001, 2005a).
(2) Second, if the increase in the exploitation of this resource during the Late Holocene was mainly due to food requirements, the expectations would be for a low or stable use of the humerus for technological purposes and a greater incidence of cut marks on more diverse anatomical elements, as a result of dismembering or filleting (Binford, 1981; Laroulandie, 2000, 2001, 2005a; Serjeantson, 2009).
(3) Last, the increase in the representation of Procellariiformes in the Late Holocene might be due to both factors. If this was the case, a higher proportion of awls would be expected and there would also be a higher incidence of cut marks on different anatomical units in assemblages of the Late Holocene.

The numbers of bones of the Procellariiformes differ between the early and late zooarchaeological assemblages, with a higher proportion of NISP in the later period (Table 2). It should be noted that the relatively low number of Procellariiformes in Túnel II (Figure 5) is due to the large quantity of cormorant remains at that site, as discussed earlier. At Shamakush X, there was a large proportion of penguins (Tivoli, 2010a, 2010b, 2010c).

The utilization of Procellariiformes for technological purposes is characterized mainly by the occurrence of bone awls, with variable quantities depending on the site (Table 2). The number of awls is not directly linked to NISP. There was a low NISP of Procellariiformes in the Mid Holocene layers of Imiwaia I (K, L, M and N),

Table 2. NISP, MNI and number of cut marks on bones of Procellariiformes from Middle and Late Holocene assemblages. The number of awls made on bird bones is also shown

	Site/ Assemblage	Radiocarbon dates (years BP)	NISP of Procellariiformes	MNI of Procellariiformes	n cut-marked specimens	Awls (Procellariiformes)
Middle Holocene Assemblages	Imiwaia I (Layers K, L, M, N)	5949 ± 50 5840 ± 44	149	16	24	11
	Mischiúen I (Layer F)	4430 ± 130 4890 ± 210	41	4	1	1
Late Holocene Assemblages	Imiwaia I (Layer B)	1577 ± 41	317	8	24	0
	Túnel II	1140 ± 90	49	3	2	0
	Mischiúen I (Layer C)	860 ± 90 1060 ± 85	737	28	69	2
	Shamakush I	940 ± 110	109	6	36	5
	Shamakush X	500 ± 100	19	2	8	0

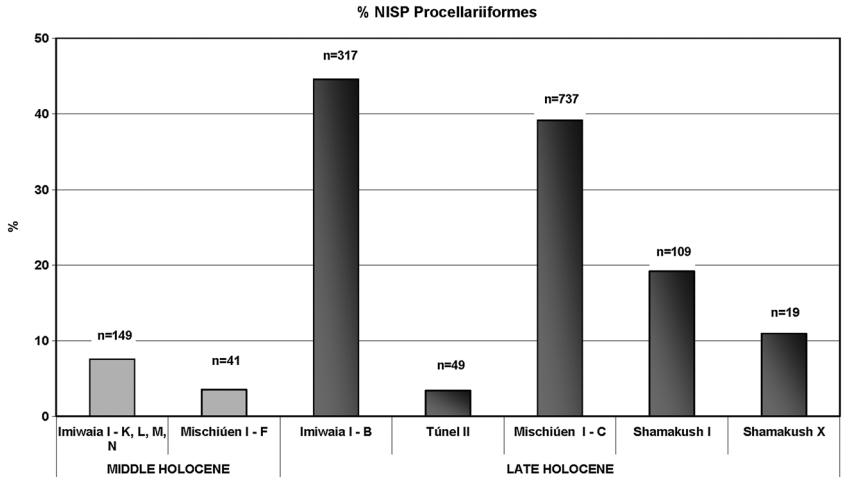

Figure 5. Percent NISP of Procellariiformes in relation to NISP in Middle and Late Holocene assemblages.

but a relatively high number of awls. The Late Holocene layer at this site (Imiwaia I, B) has a higher proportion of Procellariiformes, mainly albatrosses, but, on the contrary, no awls. Túnel II has few bones of Procellariiformes and also no awls. Shamakush I has an intermediate number of bones of Procellariiformes and also has awls. In Layer C at Mischiúen I, there was a high percentage of Procellariiformes in the avifaunal assemblage, in this case mainly shearwaters and fulmars, but the number of awls is relatively low.

This increase in the proportion of Procellariiformes in Late Holocene assemblages is accompanied by an increase in bones with cut marks in some assemblages (Figure 6). This strengthens the idea that the increased exploitation of this resource was linked mostly to food requirements. Bone processing was intense at two sites of this period in the Beagle Channel sequence: at Shamakush I and X, there is a high index of cut marks on the bones of Procellariiformes, while the frequency in other Late Holocene assemblages remains similar to that observed in the Mid Holocene assemblages.

Finally, while most cut marks are located on the axial skeleton and on the bones of the wing (Figure 7), some are also found on other anatomical elements. This indicates that butchery of the bones of Procellariformes was intense at this time. This interpretation is concomitant with the proposal in a previous paper (Tivoli & Zangrando, 2011) that there was an increase in the use of offshore fish and birds, mainly albatrosses and shearwaters, at this time. New areas were integrated into the foraging activities and pelagic prey was more actively incorporated into subsistence activities.

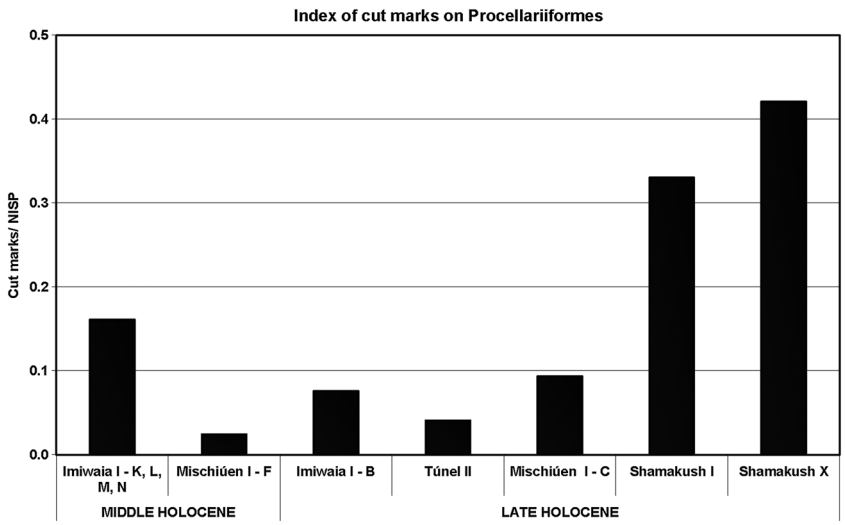

Figure 6. Numbers of bones of Procellariiformes with cut marks in relation to NISP.

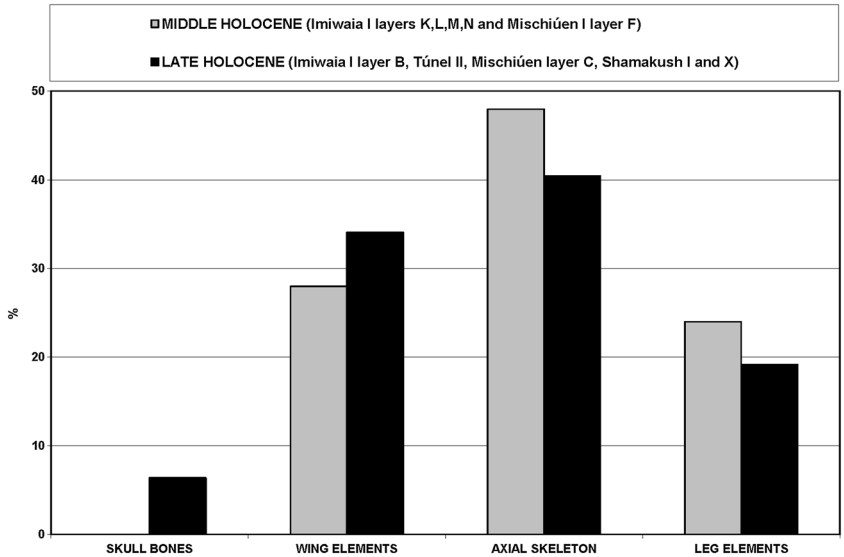

Figure 7. Proportions of cut marked bones of Procellariiformes according to anatomical categories in Middle and Late Holocene assemblages.

Summary and conclusions

The analysis developed here set out to understand the formation processes of bone assemblages with Phalacrocoracidae and Procellariiformes in the archaeological sequence of the Beagle Channel region. With regard to the cormorants, it has been shown that their representation was stable through time. Notwithstanding, different accumulation patterns were recorded for the Late Holocene avifaunal assemblages. There are two kinds of sites that are spatially disaggregated and related to distinct kinds of activities in this later period: general activity sites and special activity sites. The latter, located at high elevations, were associated with intensive exploitation of cormorants but, although there were many specific uses of these birds, no distinct pattern of butchering activities was discerned between the two different locations. So far as the Procellariiformes are concerned, it was noted that the increase in the representation of these was linked mostly to food procurement rather than to obtaining the birds as raw material. Processing the birds for consumption is the most visible activity in relation to both the Phalacrocoracidae and the Procellariiformes. The requirement for food seems to have had the most significant influence on the increase in the use of birds in Late Holocene sites in the Beagle Channel region.

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