Exploitation of bird resources among prehistoric sea-nomad societies of the Beagle Channel region, southern South America

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Abstract

The relationship between birds and prehistoric hunter-gatherer-fishers of the Beagle Channel region is analysed here. In this sense, the main goal of this paper is to characterise the utilisation of birds by these sea-nomad societies, and to explore changes and continuities of that relationship in early and recent periods of occupation. Data from eleven zooarchaeological assemblages divided into two periods are included in the analysis for comparative purposes. Results show that the late period (circa 1500-100 years BP) was characterised by an important increase in bird exploitation in comparison with earlier times (circa 6000-4000 years BP), and by changes in taxa selection. Consequently, these trends suggest changes in bird use patterns in the later periods, mostly characterised by massive captures of birds with high relative return rates (for example cormorants), and captures of taxa that usually have pelagic habits.

1 Introduction

The studied region has been inhabited by hunter-gatherer groups since at least 7000 years BP. The earliest sites in the region reflect the presence of terrestrial hunters who opportunistically exploited coastal resources. By ~6400 years BP, archaeological evidence shows the presence of groups that developed a lifestyle adapted to the seacoast (Orquera & Piana 1999a, 2006, 2007, 2009; Orquera 2005; Fiore & Zangrando 2006; Orquera et al 2006). Shell middens are the most characteristic archaeological feature in the region, and these coastal sites include evidence of a range of activities: bone tools (harpoons, awls, wedges, etc), a variety of lithic tools (scrapers, end scrapers, projectile points, etc), the use of ornaments and many bone remains indicating a diverse range of food resources used (pinnipeds, cetaceans, guanacos, molluscs, birds and fish) (Orquera & Piana 1999a, 2006, 2009). Ethnographic data also mentioned the use of bark canoes by historic maritime communities (Orquera & Piana 1999b).

Based on archaeological studies of faunal remains, it has been concluded that pinnipeds were the main source of food (Orquera & Piana 1999a, 2009; Orquera et al 2006). The capture of local big terrestrial mammals (guanacos, *Lama guanicoe*) could be more related to areas with access to inland valleys. Whales could also provide large quantities of food, but their contribution to the human diet is very difficult to evaluate: the frequency of consumption outside the campsites is unknown, and many quantities of meat and fat may have entered the camps without bone fragments (thus its consumption is not recorded). Conversely, cetacean bones could enter into sites for only technological purposes (Orquera & Piana 1999a, 2009).

In this model of coastal community subsistence patterns dominated by pinnipeds, low individual return rate resources (mussels, fish and birds) have been considered as merely dietary supplements that provided flexibility to the subsistence system (Orquera 1999; Orquera & Piana 1999a: 103–104). New studies have explored in greater depth the use of birds and fish resources and have suggested that their role was more important than previously assumed (Zangrando 2003, 2007, 2008, 2009; Mameli & Estévez Escalera 2004; Piana et al 2007; Tivoli 2010a,

2010b). Contributing to this reinterpretation is the observation that birds were widely and systematically exploited by prehistoric societies that inhabited the Magellan-Fuegian archipelago (Lefèvre 1989, 1993–1994, 1997; Orquera & Piana 1999a; Lefèvre et al 2003; Mameli & Estévez Escalera 2004).

In historical times the region was occupied by an indigenous group that named itself *Yamana.* (Orquera and Piana 1999a, 1999b, 2005, 2009; Fiore & Zangrando 2006).

Even though the maritime hunter-gatherer socio-economic organisation remained stable (Orquera and Piana 1999a, 2005, 2009) recent analyses have noticed a reorientation in the human-animal relationship for the later period of the regional occupation, i.e. since circa 1500 years BP (Zangrando 2007, 2009; Tivoli 2010a). Intensification in fishing labour investment has also been proposed for these times (Zangrando 2009). In addition, although pinnipeds were still found in most of the sites as the resource that provided the greatest amount of energy (with the exceptions of Shamakush I and Túnel VII, which is not included in the present paper), their contribution to the human diet declined in relative proportions compared to what had happened in the period 6000–4000 BP (Zangrando 2008, 2009; Tivoli 2010a). Therefore, it is of interest to investigate how the consumption of bird resources contributed to the adjustments in diet over time.

The main objective of this paper is to achieve a zooarchaeological analysis of bird bone remains from different archaeological assemblages of the northern coasts of the Beagle Channel in order to explore variations in the use of this resource in different temporal periods of the regional sequence. In this paper two central goals are presented:

i to evaluate the relationship between avifaunal ecology and hunter-gatherer subsistence through a regional-scale analysis and

ii to examine whether temporal variations involved an incorporation of new taxa in procurement activities or a reorganisation in bird hunting practices.

In order to explore these points, this paper is based on the zooarchaeological analysis of a series of sites which comprises two blocks of time of the regional record: early assemblages (circa 6000 to 4000 years BP) and recent ones (circa 1500 to 500 years BP). Eleven bird bone assemblages from five archaeological sites of this region are presented here: Imiwaia I, Mischiuen I, Túnel II, Shamakush I and Shamakush X. Five of these assemblages correspond to the earlier occupational period: layers N, M, L and K in Imiwaia I and layer F of Mischiuen I. The remaining six have been dated in the recent period: layer B in Imiwaia I, Túnel II, upper and lower C in Mischiuen I, Shamakush I and Shamakush X.

Ethnographic sources (Gusinde 1986; Bridges 1879) and archaeological researches (Scheinsohn et al 1992; Rasmussen et al 1994; Orquera & Piana 1999a, 1999b; Mameli & Estévez Escalera 2004; Fiore 2001, 2006) indicate that birds were utilised for various purposes in the Magellan-Fuegian archipelago: food, bone tools and ornamentation. We focus here on the study of the consumption of this resource as part of prehistoric diets. In this regard, a study of procurement strategies with an emphasis on taxonomic representation is carried out.

2 Contemporary ecological conditions and predictions for the zooarchaeological record

The Beagle Channel is located at the southern end of South America at 54º 50' S and between 66º 30' and 70° W (figure 1). It formerly was a glacial east-west oriented valley, invaded by marine waters approximately 8000 years ago (Rabassa et al 1986). It is a route between the Atlantic and Pacific oceans. Its length is 180 km and its width from four to seven km. Littoral relief has rugged coasts with cliffs interspersed with small pebble beaches.

Throughout the region there are a few differences in vegetation, being almost exclusively species from the Magellan forest, from sea level to 600 metres. Shrubs, grass and creeping flowering plants grow on forest margins; there are also some peat bogs (Pisano Valdés 1977; Moore 1983; Orquera & Piana 1999a). Terrestrial mammals consist mainly of guanacos (*Lama guanicoe*) and the Fuegian fox (*Pseudalopex culpaeus lycoides)*. The maritime fauna is particularly diverse and abundant: it comprises two species of pinnipeds – southern sea lions (*Otaria flavescens*) and fur seals (*Arctocephalus australis*) – and several species of cetaceans, birds, fish, molluscs, crustaceans, etc.

In this paper it is proposed that the choice of bird resources made by hunter-gatherer-fisher societies which inhabited the Beagle Channel region would have been scheduled throughout the entire occupational sequence mainly by nutritional and ecological

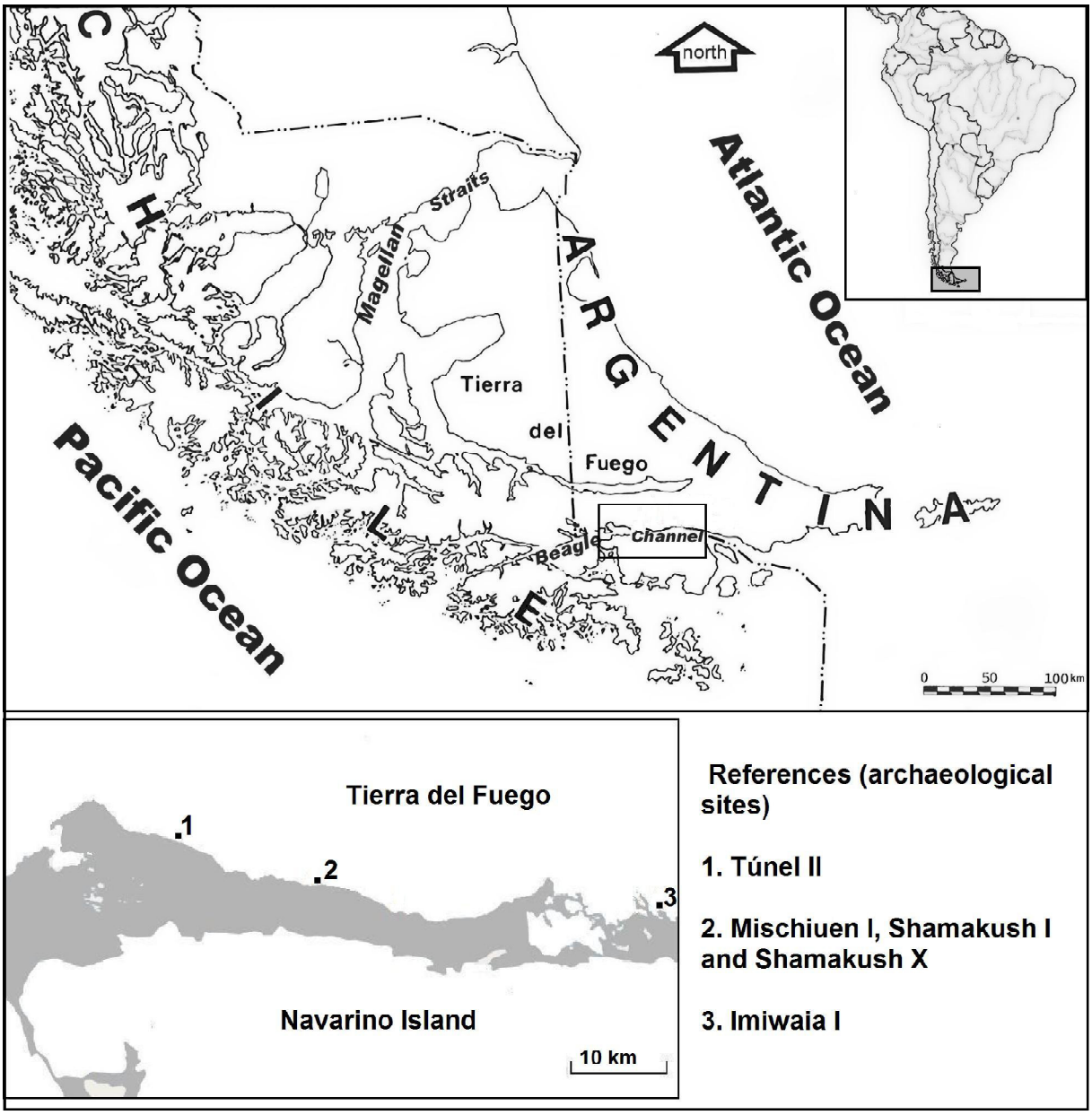


Figure 1 Beagle Channel region and studied sites

factors, which do not contradict the possible impact of social, religious or ideological factors (Fiore et al 2010). The avifauna of the Beagle Channel region is relatively abundant and diverse in their anatomical and ethological features (Table 1). Accordingly, the use of birds by the sea nomads of the Beagle Channel would have been evaluated by four main parameters:

i Individual energetic returns of different bird taxa: the highest are provided by penguins (Spheniscidae), followed in descending order by steamer ducks (*Tachyeres* sp.), upland geese (*Chloephaga picta*), albatrosses (Diomedeidae) and cormorants (Phalacrocoracidae) (Schiavini 1993; Tivoli & Pérez 2009). Considerably lower energetic returns could be obtained from gulls (Laridae) and small petrels and shearwaters (Procellariidae) (Schiavini 1993);

ii Gregariousness of different bird families: catches in colonies might have had important energetic yields that resulted in economic benefits far greater than when the acquisition was carried out on individual birds. In the first case, search costs would have declined considerably since encounter places were predictable, and since these costs would have been distributed over the amounts of individuals that were caught. Regional bird taxa that form large colonies are cormorants (Phalacrocoracidae), penguins (Spheniscidae) and kelp gulls (*Larus dominicanus*) (Humphrey et al 1970; Schiavini & Yorio 1995; Raya Rey & Schiavini 2000; Couve & Vidal 2003). Procellariiformes (albatrosses and small and large petrels) nest in colonies on islands or

mountains, protected from predators (Warham 1990), though today there are no known colonies in the Beagle Channel (Tivoli 2010a);

iii Seasonality: natural bird availability is not equal through the year. There are all year round colonies (cormorants) as well as seasonal ones (penguins). Magellanic penguins (*Spheniscus magellanicus*) live in breeding colonies on the coast during the spring and summer (November to March), but they live in the water for the rest of the year. Two species of geese (*Chloephaga picta* and *C. poliocephala*) migrate outside the region in late summer or early autumn (Humphrey et al 1970; Couve & Vidal 2003);

iv Accessibility to different species: separate birds inhabiting different spaces, which influences the possibility of being captured by hunters. In summer, Anatidae (ducks and geese) and penguins are resources readily available since they live near the coast, which implies low search costs. *Phalacrocorax atriceps* nests on coastal plains, usually associated with seabirds and pinnipeds. *Phalacrocorax magellanicus* nests on cliffs (Humphrey et al 1970; Humphrey & Livezey 1982; Schiavini & Yorio 1995; Couve & Vidal 2003), and although this fact increased the cost of capture, these colonies are highly visible and encounters are consequently very predictable. Other species, however, were harder to find and capture: eg albatrosses and petrels, which spend much of their time flying and only occasionally descend to the coast (table 1).

In sum, cormorants and penguins are the most abundant today, provide relatively high yields, are easily accessible to human hunters and could be hunted in mass because of their gregarious behaviour. Cormorants are also residents all year round, so it is expected to have been consumed on a regular basis. However, it could be the case that these taxa could not have been found or they decreased in numbers since:

- a decline in resource abundance because of changes in the environment, by enhanced activity of non-human predators or as a result of human exploitation;
- in the case of penguins, because of the seasonality of their presence;
- some sort of social restriction that would have constrained the capture of these taxa.

In any of these situations, sea nomad groups would have changed their procurement strategies in pursuit of other bird taxa which follow in descending order of economic return rate. These could have been large Anatidae (geese, steamer ducks) or large Procellariiformes (albatrosses, southern giant-petrel).

3 Zooarchaeological samples

The eleven zooarchaeological samples analysed in this paper come from five excavated shell middens. In early assemblages of Imiwaia I (layers N, M, L and K), 13.87 m^3 were excavated and the bird bones were analysed in their entirety. We also studied all the materials recovered in the 3.57 m^3 excavated of the ancient layer of Mischiuen I (F). Regarding the early assemblages, in Imiwaia I layer B a volume of 2.37 m^3 was excavated of which a 25% random sample of the dug area was studied. In Túnel II were excavated 0.76 m^3 of shell midden and all bird remains recovered were analysed. Layer C of Mischiuen I, with an excavated volume of 6.70 m^3, comprises several sub-units but only upper and lower assemblages were studied. In Shamakush I, the studied materials come from layers C, D, E and F with a total volume of 9.79 m^3, meanwhile in Shamakush X we studied bird bones of layers D and E with 1.29 m^3.

Chronologic and stratigraphic information is summarised in table 2. The NISP (number of identified specimens) and its percentages are used to determine the abundance of each taxon.

The spatial distribution of bone specimens over the shell middens is examined, and the presence of traces of burning and cut marks on some allow the inference that most bone remains are the result of

Table 1 Potential dietary yield (PDY) for the main bird families of the Beagle Channel region. Caloric values taken from Schiavini 1993 and Tivoli & Pérez 2009; weight values taken from Schiavini 1993; Rasmussen et al 1994 and Tivoli & Pérez 2009

BIRDS	Weight per individual (Kg)	Kcal per individual	Gregarious	Seasonality	Potential Dietary Yield (PDY)			
					High		Medium	Low
Spheniscidae	5.00	2880	Yes	Spring-Summer	Spheniscidae Colonies	←	Spheniscidae	
Diomedeidae	3.50	2030	No	All year			Diomedeidae	
Phalacrocoracidae	2.60	1500	Yes	All year	Phalacrocoracidae Colonies	←	Phalacrocoracidae	
Laridae	1.20	710	Yes	All year				Laridae
Procellariidae	0.70	400	No	Autumn-Winter				small Procellariidae
Tachyeres sp.	1.70	-	Yes	All year			*Tachyeres sp*	
Chloephaga sp.	3.00	2460	Yes	Summer			*Chloephaga sp.*	

anthropogenic discard of waste (Orquera et al 2006; Orquera & Piana 1999a). Furthermore, bones and fragments of different taxa exhibit cut marks on various anatomical parts (Mameli & Estévez Escalera 2004; Tivoli 2010b). Signs of combustion are also recognised as a result of cooking, bones being thrown directly on the fire or burning of a section of the site (March et al 1989; Piana et al 2004). Additionally, no taphonomic disturbances that indicate natural inputs (carnivores, roots, etc) were recorded at these archaeological sites (Tivoli 2010a). In the case of birds, the absence of many taxa that are found in the environment at present is also significant (eg, Magellanic Woodpecker, Turkey Vulture, passerines, etc). This absence is considered indicative of human selection in the formation of the zooarchaeological deposits.

The analysis focuses on discussing the taxonomic representation and – as a matter of space – does not address the anatomical representation. This information was presented and discussed in a previous paper (Tivoli 2010a). Briefly, it can be noticed that the taxa are generally represented by all the anatomical units. In order to estimate the differences in the taxonomic contribution of birds the proportions of NISP are presented, and densities calculated by the relationship between NISP and excavated volume per m^3. This estimation allows neutralising differences in the size of the excavated parts of the sites. Index of main bird taxa are also presented (eg Σ NISP cormorants / Σ NISP birds; Σ NISP penguins / Σ NISP birds, etc) (Lyman 2003; Broughton et al 2007). Taxonomic abundance is discussed by MNI (minimal number of individuals) for each assemblage.

Fragmentation of bird bone remains is evaluated in each avifaunal assemblage to establish whether there are disparities in preservation of different taxa. We use the percentage of representation of each bone specimen proposed by Zohar and coauthors (2001) (A = 100%, B = 80%, C = 60%, D = 40% and E = 25%) and an average index fragmentation through the Weighted Mean Index (WMI %) (Zohar et al 2001):

$$WMI = \Sigma (Wi * Xi) / 100$$

Where: Wi = relative frequency of each bone in each of the five categories of fragmentation; Xi = represents the five categories within each of the intervals A, B, C, D and E (100%, 80%, 60%, 40% and 25%).

4 Results and discussion

Bird samples recovered are summarised in table 2. Percentages of taxonomically identified bird specimens calculated on the basis of the total bird NISP are high in almost all assemblages with the exception of layer L in Imiwaia I (table 2).

Tables 3 and 4 show the bird taxa exploited by prehistoric human groups that inhabited the Beagle Channel region. Because of the different degrees of identification achieved, we compared the same level of taxa grouping. As a consequence, the information is clustered by families instead of species. Nevertheless, Procellariidae are separated in small and large

Table 2 Radiocarbon dates and total NISP of birds for each studied assemblage

Sites/ Assemblages	Radiocarbon years (BP)	Laboratory code	NISP (total)	NISP %	Taxonomically identified bird specimens	Percentages of taxonomically identified bird specimens (%)
Imiwaia (layer R -base-)	6390 ± 49	AA78549	0	0	0	0
Imiwaia (layer N) [IMI N]	-	-	150	1.9	91	60.7
Imiwaia I (layer M) [IMI M]	5943 ± 48 5750 ± 170	AA78550 AC 1582	418	5.3	268	64.1
Imiwaia I (layer L) [IMI L]	4900 ± 120	AC 1730	202	2.6	57	28.2
Imiwaia I (layer K) [IMI K]	5840 ± 44 5710 ± 50	AA 86509 ENEA 880	1194	15.1	622	52.1
Mischiuen I (layer F) [MISI F]	4890 ± 210 4430 ± 180	AC 1626 AC 1648	1156	14.6	721	62.4
Imiwaia I (layer B) [IMI B]	1577 ± 41 1500 ± 40 1580 ± 50	AA 86510 ENEA 882 ENEA 878	711	9	375	52.7
Tunel II [TUII]	1120 ± 90	AC 824	1436	18.2	1101	76.7
Mischiuen I (layer lower C) [MISI LC]	1060 ± 85	AC 1624	329	4.2	251	76.3
Shamakush I (layers C, D, E, F) [SHI]	1020 ± 100	AC 1293	568	7.2	338	59.5
	940 ± 110	AC 1947				
Mischiuen I (layer upper C -UC-) [MISI UC]	890 ± 90	AC 1623	1553	19.7	1149	74
Shamakush X (layers D, E) [SHX]	500 ± 100	AC 832	173	2.1	108	62.4
Total			7890		5081	

species, and the first ones are grouped with Diomedeidae because of their morphological and size similarities. The taxa less represented are grouped in "Others", there we include: Accipitridae, Ardeidae, Falconidae, Laridae and Stercorariidae.

Results indicate that Phalacrocoracidae is the most abundant bird taxon in almost all early assemblages (between 31.6 per cent in Imiwaia I [layer L], to 49.8 per cent in Imiwaia I (layer K). The exception is layer F of Mischiuen I, where the majority of specimens are Sphenisicidae (67.8 per cent) followed by Phalacrocoracidae (22.6 per cent) (table 3, figure 2). Anatidae has a second place in Imiwaia I (layers N and layer K), with 33 and 31 per cent, respectively. In Imiwaia I (layer M), Diomedeidae/large Procellariidae is the following taxon in order of importance (21.6 per cent), while layer L of the same site has the same proportion of these both taxa (22.8 per cent).

However, a shift of bird taxa exploitation is noticed for recent times (table 4, figure 3). An increase in Diomedeidae/large Procellariidae is detected in layer B of Imiwaia I and in Shamakush I (86.7 and 31.8 per cent), whereas small Procellariidae is the most abundant taxon in layer CU of Mischiuen I. There is also a relative increase in the consumption of penguins (Spheniscidae), mostly in Shamakush I and X and both early assemblages of Mischiuen I (layers LC and UC): 36; 56.5; 33.9 and 35.6 per cent respectively. With the exception of Túnel II – that indicates the case of an extremely high consumption of Phalacrocoracidae (89.4 per cent)–; this taxon shows a relative decline in relation to ancient times: Imiwaia I (layer B) and Mischiuen I (layer UC) have very low percentages (11.5 and 4.1 per cent). In Mischiuen I (layer LC), Phalacrocoracidae ranks as the second taxon in order of abundance (17.9 per cent), followed by almost the same percentages of Falconidae and small Procellariidae (16.7 and 16.3 per cent). Shamakush I presents 25.4 per cent of Phalacrocoracidae, while this taxon is totally absent in Shamakush X. Anatidae has very low percentages in all avifaunal recent collection, except in the last mentioned site, where the proportion reaches 23.1 per cent.

The WMI% index shows that there are no major differences between fragments of the different bird families represented. Penguins seem to have a higher proportion of preserved bones (between 55 and 75 per cent), but the differences with other taxa are minimal; generally it is observed an overlapping of values (figure 4: taxa that are marked with zero per cent are the ones absent from these sets). Thus, it cannot be possible to attribute the differences noticed above as a factor linked to differential fragmentation between

Table 3 NISP of bird taxa for early assemblages

	EARLY ASSEMBLAGES									
	IMIWAIA - N		IMIWAIA - M		IMIWAIA – L		IMIWAIA - K		MISCH. I - F	
	N	%	N	%	N	%	N	%	N	%
Anatidae	30	33.0	41	15.3	13	22.8	192	30.9	9	1.2
Diomedeidae and large Procellariidae	12	13.2	58	21.6	13	22.8	48	7.7	41	5.7
small Procellariidae	5	5.5	1	0.4	2	3.5	14	2.2	0	0
Phalacrocoracidae	35	38.5	123	45.9	18	31.6	309	49.7	163	22.6
Spheniscidae	8	8.8	42	15.7	9	15.8	52	8.4	503	69.8
Others	1	1.1	3	1.1	2	3.5	7	1.1	5	0.7
TOTAL	**91**		**268**		**57**		**622**		**721**	

Table 4 NISP of bird taxa for recent assemblages

	Imiwaia I - B		Túnel II		Mischiuen I - lower C		Shamakush I - C, D, E, F		Mischiuen I - upper C		Shamakush X - D, E	
	N	%	N	%	N	%	N	%	N	%	N	%
Anatidae	4	1.1	0	0	3	1.2	12	3.5	3	0.3	25	23.1
Diomedeidae and large Procellariidae	325	86.7	3	0.3	15	6.0	108	31.8	62	5.4	18	16.7
small Procellariidae	2	0.5	46	4.2	41	16.3	2	0.6	619	53.9	1	0.9
Phalacrocoracidae	43	11.5	984	89.4	45	17.9	86	25.4	47	4.1	0	0
Spheniscidae	0	0	63	5.7	85	33.9	122	36.0	409	35.6	61	56.5
Others	1	0.3	5	0.5	62	24.7	9	2.6	9	0.8	3	2.8
TOTAL	**375**		**1101**		**251**		**339**		**1149**		**108**	

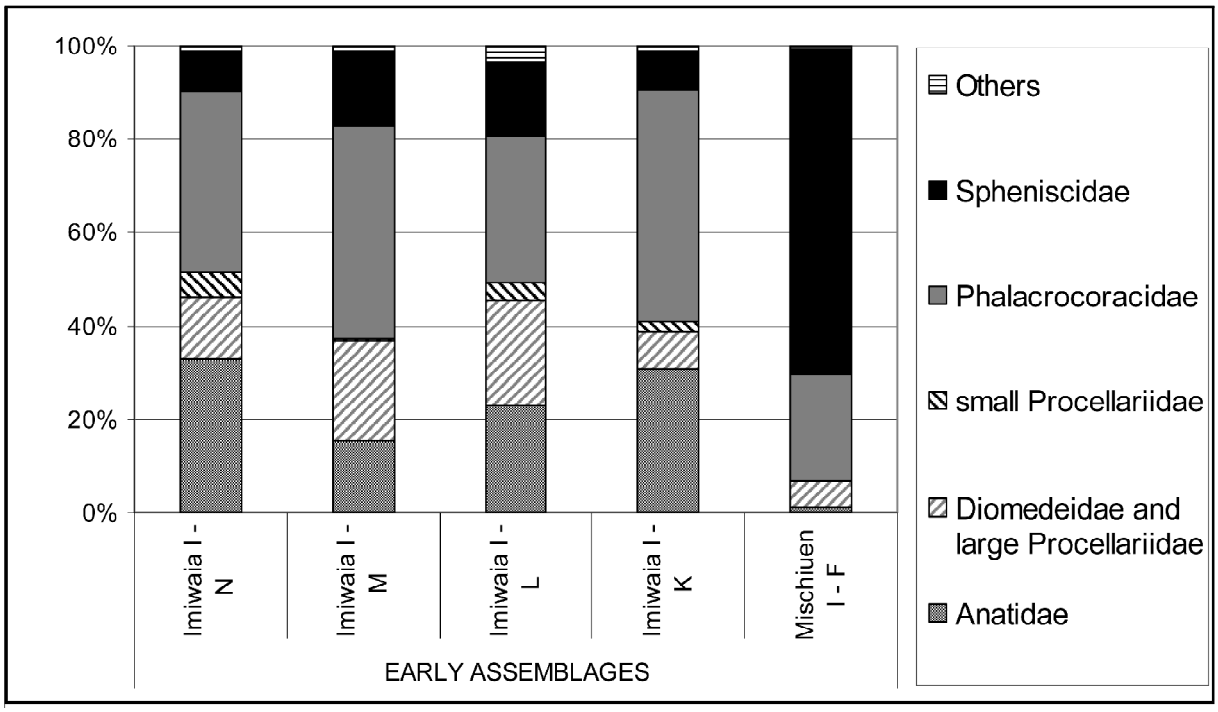


Figure 2 Percentages of NISP per taxa for early assemblages

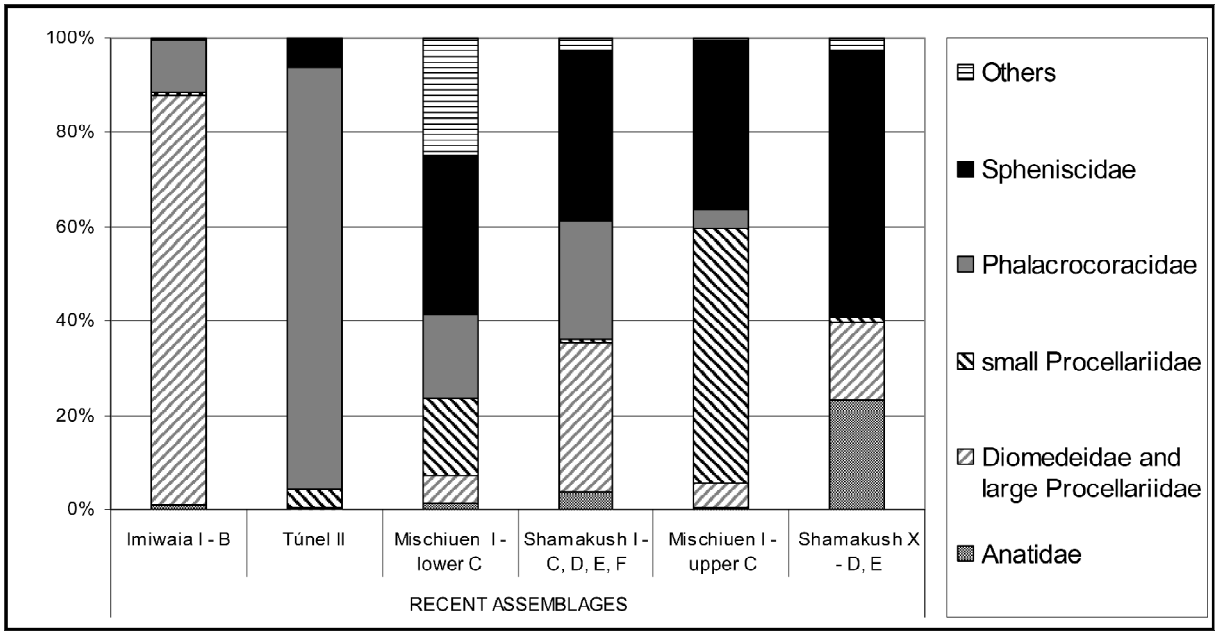


Figure 3 Percentages of NISP per taxa for recent assemblages

assemblages and / or different taxa.

Taking into account the information presented above, we could suggest a relative increase in the consumption of birds over time. Numbers of specimens of birds indicate a rise in the exploitation of this resource in recent zooarchaeological assemblages. The distributions of values of NISP per m^3 of excavated sediment show that early assemblages have an average of 180.7 ± 112.7 specimens with minimum value of 63.5 and maximum of 323.8, while recent assemblages present an average of 608.1 ± 633.5 per m^3 (minimum 66.7 and maximum 1574.8) (figure 5). It could be the possibility of a differential preservation thought time and, therefore, an increase in the number of bone specimens recovered in older assemblages (Tivoli 2010a). However, the WMI% indices presented above show high survival values in all assemblages: there are no significant differences between species and assemblages of diverse chronologies. Moreover, bone preservation in archaeological deposits of the Beagle Channel is generally excellent: shell middens are stable in the pH and moisture conditions (Linse 1992; Orquera & Piana 2000, 2001). In conclusion, we think that the overall pattern

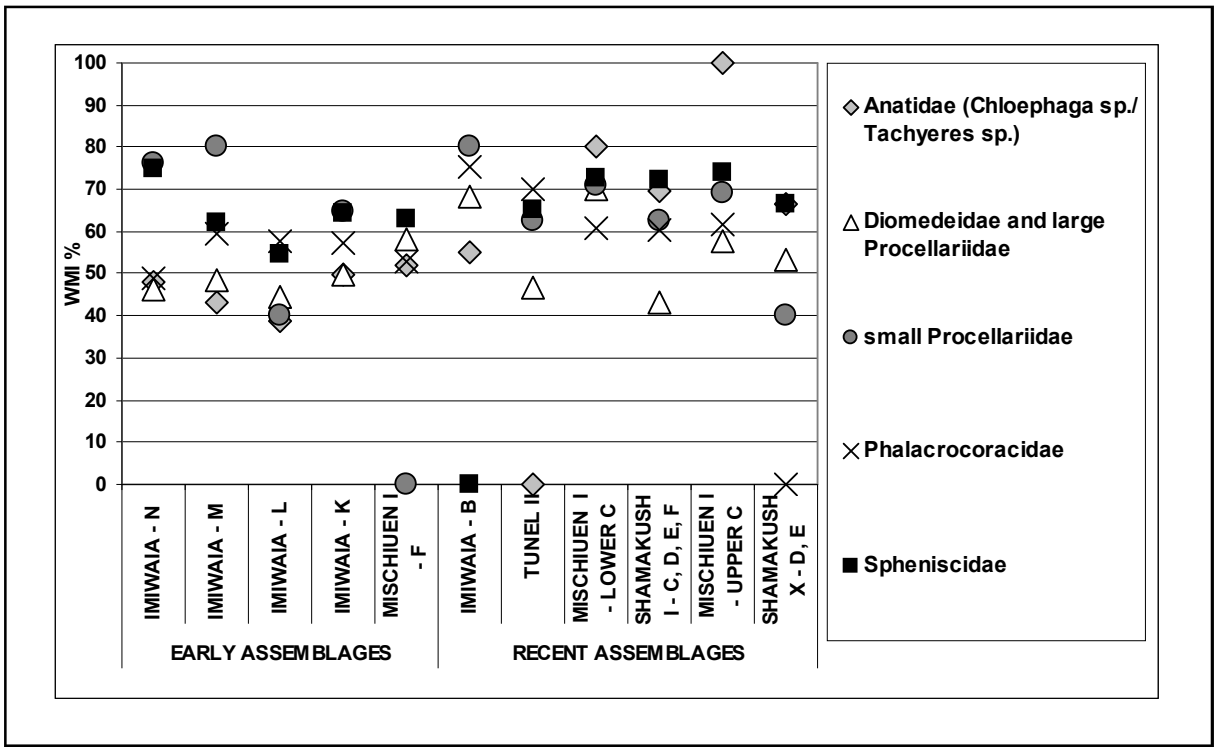


Figure 4 Weighted Mean Index (WMI %) for all bird bone assemblages

of avifaunal assemblages was not driven by bone fragmentation or other taphonomic factors.

Also some variations in the taxonomic composition of the samples are noticeable. Early zooarchaeological assemblages of the regional sequence are dominated by cormorants and/or penguins, while from the last 1500 years before present an increase in the consumption of Procellariiformes (petrels, shearwaters and albatrosses) is noticed (figures 6 and 7). This happens mainly in layer upper C of Mischiuen I and in layer B of Imiwaia I (increase of small Procellariidae and Diomedeidae, respectively).

However, high representations of cormorants and penguins are detected in almost all archaeological assemblages analysed in this paper (figures 2 and 3). Since these birds are the most energy-efficient due to their weight, energy and gregarious habits, the higher representations of these birds are consistent with the expectations proposed at the beginning of this paper. There are also sites within the recent period that only show a high consumption of cormorants and not of penguins: Túnel II and Shamakush VIII – not included in the present paper – (Piana & Canale 1993–1994; Piana & Vazquez 2005). Therefore, it could be proposed the development of two possible strategies of bird acquisition that were not detected in the earlier period:

i massive capture of birds with high relative return rate (eg, cormorants) and

ii the capture of taxa that usually have pelagic habits.

Both types of strategies could have been the result of the need to coordinate tasks of prey procurement. In the first case, by obtaining a large number of individuals per hunting party and; second, by combining the tasks of hunting birds and fishery in pelagic areas. It could also be the case that hunter-gatherers reached colonies of those pelagic bird taxa. However, it is relevant to highlight that in the case of birds it is more difficult to ascertain if the catches were made off or near the coast. Black-browed albatross and southern giant petrel usually fly near the coast, which could have facilitated their acquisition. Nevertheless, the coincidence in the reorientation of bird taxa captures is in agreement with the modification of fishing activities in later phases of the regional sequence. The largest catches of *Thyrsites atun* indicate the intensification of labour input for the search of fish resources: it was necessary to obtain them in offshore waters (Zangrando 2009). It could then be possible to propose that hunter-gatherer-fishers combined those fishing activities with the capture of pelagic birds, maybe reaching their colonies. However, this does not mean that this is the only method of obtaining

such bird taxa. As described above, some species of Procellariiformes are found close to the coast, probably attracted by the presence of food (fish shoals, beached of cetaceans, dead animals, etc).

With regard to possible episodes of massive hunting, although it might be thought that this activity was highly efficient, it should be noticed that the skeletal remains of a large number of these individuals were discarded as complete skeletons or as partial skeletons (Piana et al 2007, and personal observation). This could indicate an incomplete exploitation of these prey as food, or it might also be the case that the captures had other purposes, such as the getting of bones or feathers for making tools or implements for decoration. It is important to mention that in several sites of the region artefacts made from bird bones have been recovered, mainly awls (manufactured on humerus, tibiotarsus, ulna and radius) (Scheinsohn et al 1992; Orquera and Piana 1999a; Tivoli 2010a). However, these assumptions are somewhat premature because more detailed analysis has to be done relative to cut marks, disarticulation, patterns of discard of bone remains and to the stages in the manufacture of instruments. It is also noteworthy that this activity of large catches of gregarious birds did not involve an increase in their average consumption by recent times.

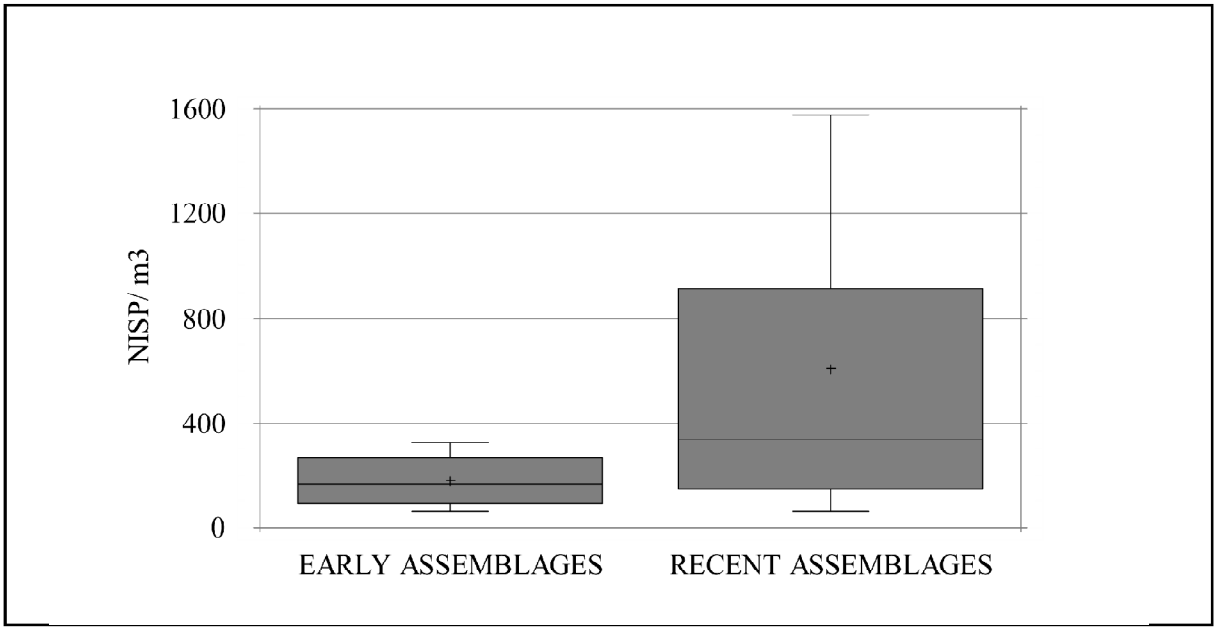


Figure 5 Box-plot of specimens of birds per m³ of excavated sediment

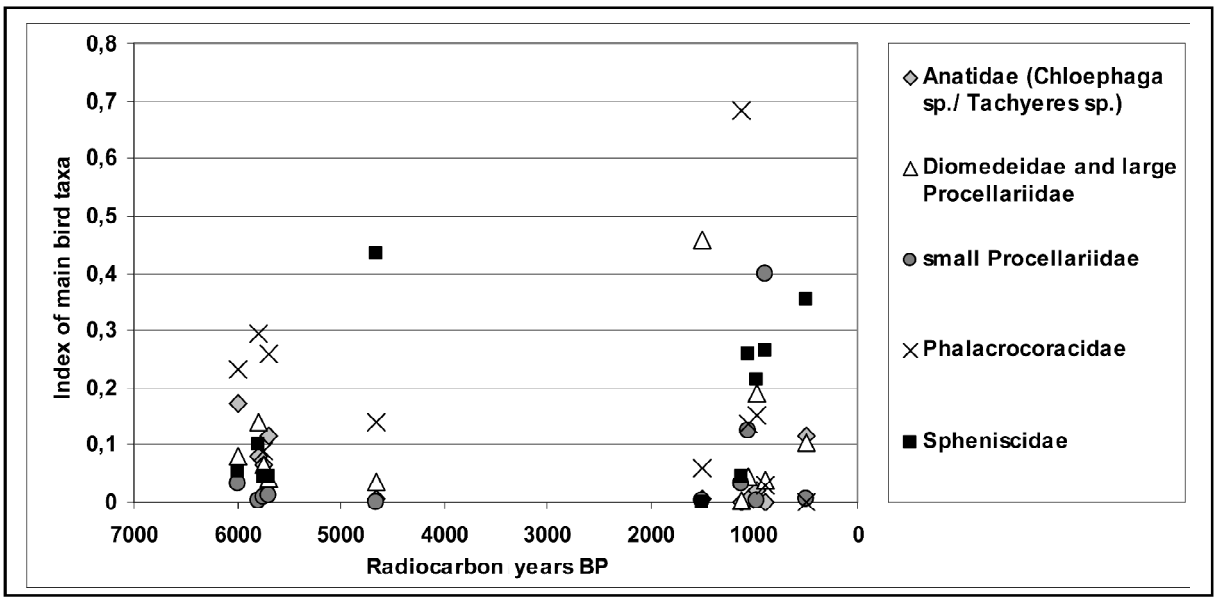
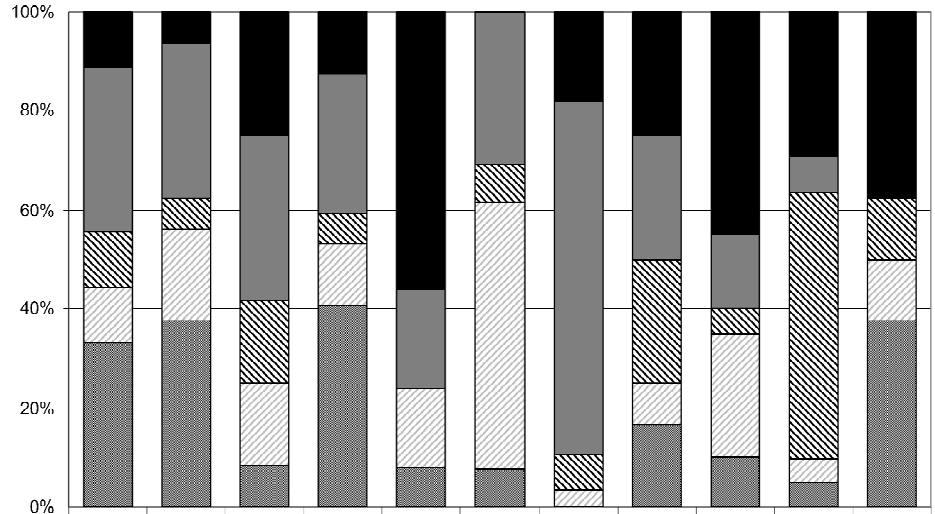


Figure 6 Index of main bird taxa
NISP of each main bird taxa / Σ NISP birds



	IMI (N)	IMI (M)	IMI (L)	IMI (K)	MISI (F)	IMI (B)	TUII	MISI (LC)	SHI	MISI (UC)	SHX
	EARLY ASSEMBLAGES					RECENT ASSEMBLAGES					
Spheniscidae	1	1	3	4	14	0	5	3	9	12	3
Phalacrocoracidae	3	5	4	9	5	4	20	3	3	3	0
small Procellariidae	1	1	2	2	0	1	2	3	1	22	1
Diomedeidae and large Procellariidae	1	3	2	4	4	7	1	1	5	2	1
Anatidae	3	6	1	13	2	1	0	2	2	2	3

Figure 7 MNI of bird taxa for all assemblages
References: IMI (N): Imiwaia I (layer N); IMI (M): Imiwaia I (layer M); IMI (L): Imiwaia I (layer L); IMI (K): Imiwaia I (layer K); MISI (F): Mischiuen I (layer F); TUII: Túnel II; MISI (LC): Mischiuen I (layer lower C); SHI: Shamakush I; MISI (UC): Mischiuen I (layer upper C); SHX: Shamakush X

5 Conclusions

The main goal of this paper was to examine long-term interactions between hunter-gatherer-fisher societies and bird resources of the Beagle Channel region. Following this overall aim, the role of birds in the socio-economic organisation of these human populations was analysed, exploring which taxa were the main sources of food and searching for possible changes over time. In this sense, two main conclusions are presented.

First, a high consumption of birds nesting in the area is evidenced throughout the archaeological sequence, mainly cormorants and penguins. This is consistent with expectations arising from the ecological conditions. In spite of this, an observation should be made with regard to penguins. According to the results of this work, we observe that the exploitation of this resource was continuous during the studied periods, and in moderately high rates. However, the intensive consumption of penguins over 6,000 years could have not been feasible given the current limited availability of this resource, with a single colony of Magellanic and gentoo penguins in the Beagle Channel.

Second, trends of change over time have been detected: on the one hand, there is a clear increase in the relative abundance of bird remains in assemblages after 1500 years BP. On the other hand, it seems that an increase in the consumption of birds was articulated with two strategies: massive captures in coastal areas and exploitation of pelagic birds. Both strategies could have involved an increase in labour investment for the capture of birds in later phases of the regional sequence.

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