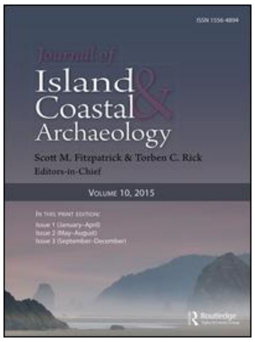

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The Role of Ancient Fishing on the Desert Coast of Patagonia, Argentina

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ABSTRACT

This article explores latitudinal and chronological variations in the exploitation of marine fish by the hunter-gatherers who occupied the Atlantic coast of continental Patagonia, Argentina, since the mid-Holocene. Results indicate a spatial gradient in the importance of fish. A significant reduction in the frequency of fish remains in the archaeological sites occurs at higher latitudes. The chronological trends identified also suggest differences between the assemblages of the northern and southern coasts of this long littoral area. The results obtained are further discussed in relation to identified environmental and cultural variation.

Keywords Argentina, desert coast, fishing, hunter-gatherers, latitudinal gradient, middle and late Holocene, Patagonia

INTRODUCTION

The aim of this article is to explore the spatial and temporal variability of fish exploitation along the Patagonian Atlantic coast during the last 7000 years BP. This area extends from the mouth of the Colorado River (39° 50S) to the northern shore of the Strait of Magellan (52° 22S), a distance of more than 2600 km (Figure 1).

Although the Patagonian Sea is one of the most productive marine regions in the southern hemisphere (Falabella et al. 2009), previous archaeological research along this huge coastline has produced only scarce and fragmentary evidence of fish consumption by hunter-gatherers (Orquera and Gómez Otero 2007). Currently available information about fish remains is unsystematic and concentrated in only certain sectors of this long maritime coast. In this sense, in order to know better the role of these resources, it is necessary to explore their abundance on a larger scale as has recently been done by Zangrando and Tivoli (2015) for the southern Atlantic coast and Fuego-Patagonia. Regional

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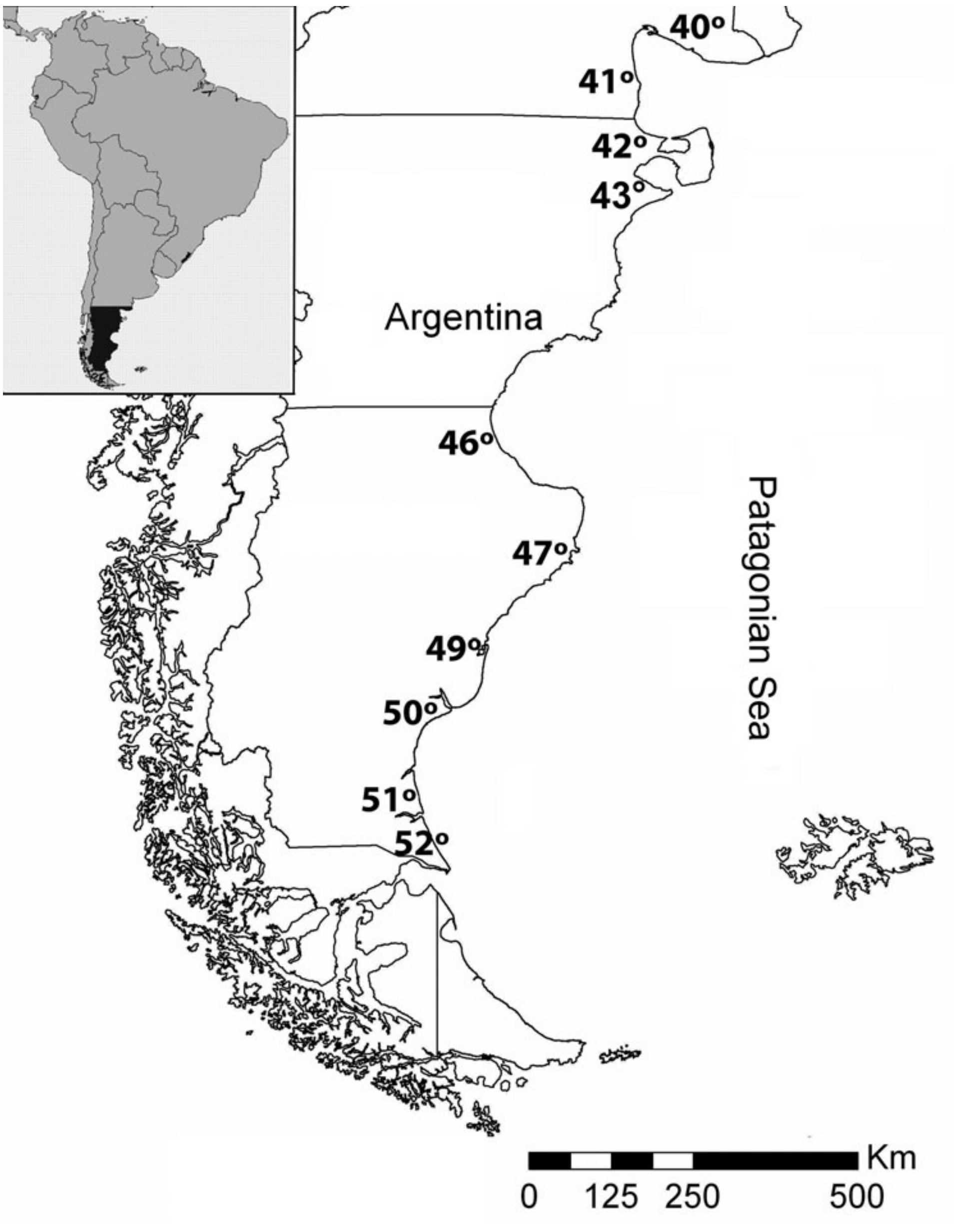

Figure 1. *Map of the Argentine Patagonian coast.*

cases play a key role in the exploration of general patterns at different scales. They sacrifice scope and resolution, but provide an adequate perspective for understanding the sources of regularities as well as anomalies. A regional model of fish exploitation on the Atlantic coast of Patagonia should allow us to explore variability in the use of fish as a subsistence resource and the possible causes of this. It also permits us to evaluate particular cases in greater detail, including the relevance of local issues that have conditioned or favored past fishing practices, such as coastal geomorphology, type of substrate, upwellings, and sea fronts, amongst others.

THE PATAGONIAN COAST AND SEA: ENVIRONMENTAL BACKGROUND

Extra-Andean Patagonia is a semi-arid to arid region of Argentina that contains the largest desert in America, covering some 670,000 km^2. This vast region is bounded to the west by the Andean Range, to the north by the Colorado River, to the south by the Strait of Magellan, and eastward by the Atlantic Ocean (Figure 1). The Atlantic coast of Patagonia stretches over 2600 km. Structurally it consists of a system of plateaux dissected by fluvial valleys and topographical depressions modified by marine action. This creates a relatively rugged coastline where cliffs alternate with sand and gravel beaches, coves, and capes (Schellmann and Radtke 2010).

The Patagonian desert exhibits low to temperate temperatures. In the coastal area temperatures vary between 29°C and −2°C, depending on the season, with a summer average of 20°C and winter temperatures only rarely exceeding a range of 6–10°. Rainfall varies between 100 and 430 mm per year, but on average is not greater than 200 mm per year. South of 40°S, rainfall decreases from west to east. The latitudinal and altitudinal distribution of vegetation in Patagonia is mainly related to these climatic conditions and to geomorphological and edaphic characteristics. From north to south vegetation is represented by xerophytic woodlands of the Espinal, Monte xerophytic shrublands, and the Patagonian steppe (Cabrera and Willink 1980; Roig et al. 2009).

The term "Patagonian Sea" is the name used to identify a vast oceanic ecosystem extending over some 1,000,000 km^2 to the east of the Argentine mainland (Mianzan and Acha 2008). It is a highly productive environment with an abundance of phytoplankton nearly three times greater than the mean recorded for the world's oceans (Falabella et al. 2009). It is also home to a great diversity of animal life, including extensive populations of 600 vertebrate species, among them 64 species of seabirds, 47 species of marine mammals, and 403 species of fish (Díaz de Astarloa 2008).

The Patagonian Sea and the adjacent zone are exposed to the ecological effects of the fronts generated by the Malvinas and Brazil Currents. Two distinct biogeographic provinces have developed in association with these two masses of water. The first is the Argentine province, which is related to the warm waters of the Brazil Current. The second, the Magellanic province, is dependent on the cold Malvinas Current. The Sub-Antarctic-Subtropical convergence occurs between 41° and 43°S (Piola and Matano 2001) and generates high bio-productivity and an area rich in marine biodiversity. In the Patagonian Sea, phytoplankton availability between 39° and 46°S is unusually high. This is where the transition occurs between the waters of the continental shelf and the Malvinas Current. Fronts are also observed in coastal areas, especially to the east of the Gulfs of San Matías (41°S) and San Jorge (42°S) (Boltovskoy and Correa 2008). During spring and summer, these fronts intensify and correspond with areas of high biological productivity. In autumn and winter, the inner shelf fronts are less intense and only the fronts associated with the slope, with the mid-shelf north of 42°S, and with the Subtropical-Sub-Antarctic transition zone in the Brazil-Malvinas Confluence are evident (Tonini 2010).

In general, as we have already noted, the Patagonian Sea's fish stocks achieve a high biomass (Díaz de Astarloa 2008). Nevertheless, the diversity of fish species is relatively low, as is typical of temperate seas. Most fish diversity is provided by release of water from the southern Brazil Current. Among the principal species found are *Diplodus argenteus*, *Acanthistius brasilianus*, *Conger patachonicus*, *Umbrina canosai*, *Micropogonias furnieri*, *Dules auriga*, *Engraulis anchoita*, and *Merluccius hubbsi*. On the other hand, the Magellanic province is mainly composed of pelagic and demersal species such as *Micromesistius australis*, *Macruronus magellanicus*, *Sprattus fueguensis*, *Genypterus blacodes*, *Merluccius australis*, *Dissostichus eleginoides*, *Salilota australis*, Macrouridae, and *Nothenia* spp. (Díaz de Astarloa 2008). In the Patagonian tidal zone, Fuegian sprat (*Sprattus fueguensis*) and hake (*Merluccius hubbsi* and *M. australis*) are the most abundant fish resources, providing food for large populations of seabirds and marine mammals (Acha et al. 2004).

ETHNOHISTORICAL AND ARCHAEOLOGICAL BACKGROUND

Archaeological research on the Patagonian coast has been ongoing since the beginning of the twentieth century. However, systematic work began only at the end of that century (Orquera and Gómez Otero 2007). To date, more than 400 archaeological loci have been recorded throughout this long coastline (Zubimendi et al. 2015).

The oldest occupations known go back to the middle Holocene ca. 7000 BP at the Arroyo Verde site, which is located on the western coast of San Matías Gulf (Gómez Otero 2007). Despite this, the majority of the coastal occupations known for this area are restricted to the last 2,000 years (Orquera and Gómez Otero 2007). To date, no evidence of navigational technology has been recorded along this extensive coastline, unlike the situation in nearby areas, such as the Tierra del Fuego channels and the Pacific slope of Patagonia. The Atlantic coast of Patagonia was thus mainly occupied by terrestrial hunter-gatherers who made variable use of coastal environments and resources. The faunal and isotopic data recovered from this area indicate the use of marine and continental resources (Favier Dubois et al. 2009; Gómez Otero et al. 2007; Martínez et al. 2012; Moreno et al. 2011). On both coastal and continental sites, guanaco (*Lama guanicoe*) was the main resource from the beginning of human occupation (L'Heureux and Cornaglia Fernandez 2015). This camelid species was present in large numbers and was homogeneously distributed throughout Patagonia (Raedeke 1979), which explains the enormous attention it has had in Patagonia archaeology (Mengoni Goñalons 1999, amongst others). However, after more than 30 years of systematic research we still know very little about the consumption of other resources, such as fish (Orquera and Gómez Otero 2007).

The first image that emerges from the chronicles of nineteenth-century literate travelers in the region is that fish were not only not considered to be food, but were actively despised by the native people of the Patagonian coast. There are thus only a few ethnohistoric references about fishing or eating fish from the Atlantic coast of Argentina. The English traveler George Musters wrote in the mid-nineteenth century that "*the Indians, however, except Casimiro, would not eat the fish, and evidently regarded our enjoyment of them much as an Englishman would at first view their appreciation of blood*" (Musters 1871:115–116). A similar observation was made by Theophilus Schmid, when he observed that the Patagonians "never eat fish, even the best salmon, but oysters and mussels as variation" (Schmid 1964:177). However, we must not forget that during the eighteenth and nineteenth centuries Patagonia's native population gained great mobility with the introduction of the horse, which led to significant changes in their social and economic organization (Nacuzzi 1998). In this sense, although these accounts are valuable in multiple ways they cannot provide an exact picture of the world of Patagonian hunter-gatherers as it existed before European arrival.

Archaeological references about fish consumption in the Patagonian Atlantic coast are sparse and incomplete. In general, they consist of simple references to the presence/absence of fish, in many cases without additional information about species or size. This lack of information and the ethnographic image of people not eating fish have favored a limited interest in these archaeofaunas. However, in recent years the use of more appropriate methodologies and growing interest in the use of small resources have begun to throw more and better light on fish consumption in this macro-region (Cruz et al. 2007). In some areas of the Patagonian coast fish were a resource scarcely consumed, while in others they played a prominent role in human subsistence (e.g., along the southern coast of Buenos Aires and northern coast of Rio Negro provinces). Archaeological research carried out in the northern coast of Rio Negro province has documented systematic fishing activities since the middle Holocene. Indeed, for this portion of the Patagonian coast, isotopic, archaeofaunal, and technological data are all consistent with the importance of this resource since middle Holocene times (Favier Dubois et al. 2009; Scartascini 2012, 2014). In this context a regional integration of available data to assess changes in the consumption of these resources is both necessary and overdue. This paper is a first approach in this regard.

SAMPLE AND METHODOLOGY

The sample used in this study comes from bibliographic sources ($N = 39$) published up to August 2105, which collectively yielded a total of 59 sites. Data about faunal abundance were taken from archaeological sites located in coastal environments at a distance not greater than 5 km from the present coast. The sites considered represent a time period from ca. 7000 to 400 years BP. Only buried contexts with published NISP values were included in the analysis. The total sample analysed reaches a NISP of 61,851 specimens of which only 19,344 (31%) were fish remains.

The information was grouped into a data matrix (Table 1), where each site was recorded in a latitudinal range of 0.5 degrees, before being clustered into larger intervals (of one degree) to reduce local variability. Finally, the frequency data were transformed to logarithms to run a regression analysis.

RESULTS

Before proceeding with the spatial and temporal analysis brief mention must be made about the formational and taphonomic aspects of the samples studied. The preservation contexts of the faunas analyzed are similar throughout the studied area. In most cases the samples come from shell midden sites located adjacent to the current coastline, which suggests that the samples share a similar sedimentary context and taphonomic history. Similarly, there is a unified methodology for the excavation of these contexts, which also includes the use of fine mesh (1 mm) to screen the sediment. Another aspect that needs to be considered is the differential preservation of species and bony elements, although this point is harder to assess with the information currently available. As discussed earlier, detailed ichthyoarchaeological data are scarce for most of the Patagonian coastline and in most cases there is only a mention of presence/absence in site reports. This does not allow an accurate assessment to be made of differences between the species and/or skeletal elements involved. Considering this, the methodological strategy developed in this work is to bring together all the remains of different species in a unique and inclusive taxonomic category "fish" which includes all the elements that could be identified as fish, regardless of whether or not they were identifiable in a more detailed taxonomic category (e.g., species, genus, family). We know that this means neglecting inter-specific differences and their preservation potential. In the future when more and better taxonomic data became available, this analysis can be reevaluated. Considering that the taxonomic category "fish" allows targeting the subsistence practice of our interest at a broad level, this operative decision does not introduce significant biases for the current analysis. On the other hand, and when more refined data become available, the important point to stress is that this methodological decision allows producing a macro-regional exploration of the role of fish resources in ancient societies. On the basis of the results presented here, we will pursue more finely refined analyses in the future.

For this article 36 surface sites were excluded. Most of them correspond to "atypical" assemblages recovered on the north coast of San Matías Gulf. In this particular

***Table 1.* Archaeological sites surveyed in the Patagonian Atlantic coast.**

Area	Locus	14C BP	Latitude °S	Fish NISP	Σ NISP	References
South Buenos Aires	San Antonio 1	773 ± 44	39.5°	1763	1810	Martínez 2008–2009; Stoessel 2012
	San Antonio 2	764 ± 45	39.5°	139	369	Stoessel 2012; Stoessel et al. 2008
	San Antonio 4	no data	39.5°	10	20	Stoessel 2012
	El Haras S1	3070 ± 70	40°	1	94	Eugenio and Aldazabal 2004
	Las Olas 11	2810 ± 50	40°	54	4980	Aldazabal et al. 2011
	El Piche 1	1500 ± 40	40°	2	536	Eugenio and Aldazabal 2004
Rio Negro	Bahía Creek Paleo. S1	5110 + 80	40°	47	47	Favier Dubois and Scartascini 2012; Scartascini 2014
	Paesani S2	no data	40°	8	84	Marani 2015; Scartascini 2014
	Paesani S3	no data	40°	357	450	Marani 2015; Scartascini 2014
	Paesani S4	no data	40°	26	151	Marani 2015; Scartascini 2014
	Paesani S5	1150 + 60	40°	853	2060	Favier Dubois 2013; Marani 2015; Scartascini 2014
	Paesani S6	no data	40°	6	24	Marani 2015; Scartascini 2014
	Bajo de la Quinta Sector 1 S2	3110 ± 100	40.5°	1193	2307	Marani 2011
	Bajo de la Quinta Sector 3 GPS 80	1040 + 60	40.5°	848	868	Favier Dubois and Kokot 2011; Scartascini 2012
	Bajo de la Quinta LNE GPS 125	1070 + 60	40.5°	493	707	Favier Dubois and Kokot 2011; Scartascini 2012
	Bajo de la Quinta LNE GPS 126	942 + 37	40.5°	231	396	Favier Dubois and Kokot 2011; Scartascini 2012
	Bajo de la Quinta LNO GPS 142	804 + 37	40.5°	218	413	Favier Dubois and Kokot 2011; Scartascini 2012
	Bajada de los Pescadores S2	2197 ± 38	40.5°	65	543	Borella and Cruz 2012
	Saco Viejo Historico S3	no data	40.5°	87	87	Scartascini 2014
	Saco Viejo Historico S2	1940 + 70	40.5°	138	181	Favier Dubois 2013; Scartascini 2014

(Continued on next page)

Table 1. **Archaeological sites surveyed in the Patagonian Atlantic coast. *(Continued)***

Area	Locus	14C BP	Latitude °S	Fish NISP	Σ NISP	References
	Saco Viejo Caserio S1	2170 + 70	40.5°	2001	2138	Favier Dubois 2013; Scartascini 2014
	Playon Cementerio S1	5290 + 39	40.5°	2330	2350	Favier Dubois and Scartascini 2012; Scartascini 2014
	Playon Cementerio S2	no data	40.5°	1210	1210	Scartascini 2014
	Pta. Odriozola Sect 2 S1	3520 ± 70	41.5°	685	770	Borella et al. 2015
	Pta. Odriozola Sect 2 S2	3260 ± 80	41.5°	402	1236	Borella et al. 2015
	Pta. Odriozola Sect 3 S2	2610 ± 80	41.5°	18	19	Borella et al. 2015
	Pta. Odriozola Sect 3 S2	3300 ± 90	41.5°	40	65	Borella et al. 2015
North Chubut	Los Abanicos Fogon 1	no data	42.5°	77	1924	Gómez Otero and Suárez 1999
	Bahía Cracker 4 M1-cud1	5390 ± 130	42.5°	830	967	Gómez Otero et al. 2013
	Bahía Cracker 8	4890 ± 80	42.5°	28	390	Gómez Otero et al. 2013
	Rincon Elizalde 1 C1	2220 ± 70	42.5°	7	21	Gómez Otero 2007
	Eriach 1 M3	2450 ± 60	42.5°	1	9	Gómez Otero 2007
	Barranca Norte 2 N2	no data	42.5°	272	689	Gómez Otero 2008
	La Armonia M2	460 ± 45	42.5°	164	1390	Gómez Otero et al. 2002
	Barranca Norte 1 F1	1040 ± 70	42.5°	31	973	Gómez Otero 2008
	Los Cangrejales S4-L1	2120 ± 40	43°	2	3	Svoboda and Gómez Otero 2015
	Los Cangrejales S4-L2a	2040 ± 90	43°	394	511	Svoboda and Gómez Otero 2015
	Los Cangrejales S4-L2c	2290 ± 90	43°	82	94	Svoboda and Gómez Otero 2015
	Los Cangrejales S4-L3	1980 ± 60	43°	166	192	Svoboda and Gómez Otero 2015
	Los Cangrejales S4-L2b	no data	43°	148	154	Svoboda and Gómez Otero 2015

(Continued on next page)

Table 1. **Archaeological sites surveyed in the Patagonian Atlantic coast. *(Continued)***

Area	Locus	14C BP	Latitude °S	Fish NISP	Σ NISP	References
	Los Cangrejales S5-Lo inf	590 ± 70	43°	4	17	Svoboda and Gómez Otero 2015
	Los Cangrejale S5-L1	840 ± 60	43°	70	221	Svoboda and Gómez Otero 2015
North Santa Cruz	Sitio Moreno	2720 ± 50	46.5°	2950	2960	Moreno 2008; Moreno and Castro 1995
	Palo Alto	690 ± 90	47°	102	568	Zubimendi et al. 2009, 2010
	Palo Caido	560 ± 60	47°	2	354	Zubimendi et al. 2009, 2011
	Laguna del Telégrafo	2357 ± 40	47°	6	516	Trola et al. 2007
	El Piche	1850 ± 90	47°	71	2863	Trola et al. 2007
	Cabo Blanco 1	1700 ± 30	47°	37	1646	Moreno et al. 1998; Moreno 2008
	Medanos del Salitral	no data	47°	12	105	Moreno et al. 2004
	Cueva Del Negro	1340 ± 60	47.5°	350	11681	Beretta et al. 2011; Zubimendi et al. 2011
	Las Hormigas	370 ± 40	47.5°	8	1777	Hammond 2013
	Los Albatros	1040 ± 80	47.5°	49	234	Bogan et al. 2007; Zubimendi and Hammond 2009
South Santa Cruz	P96	ca. 1750–900	50°	7	3411	Cruz et al. 2015
	Monte León	1380 ± 50	50°	2	259	Caracotche et al. 2006
	Yegua Quemada 3	5360 ± 20	50.5°	33	121	Caracotche et al. 2013
	CCH 4	1380 ± 50	50.5°	2	206	Cruz et al. 2011
	HST01AM	890 ± 90	51°	195	2435	Mansur 2007
	Cabo Vírgenes 1	1380 ± 70	52°	1	86	Barberena et al. 2004
	Cabo Vírgenes 6	ca 1200	52°	16	1159	L'Heureux and Franco 2002

area were detected a large amount of surface sites where hundreds of otoliths of at least three sciaenid species associated with lithic net weights were recovered. The highest frequencies of assemblages dominated by otoliths were found on the north coast of San Matias Gulf (Rio Negro Province- 41 S-) and its frequency drops significantly south of this Gulf (42 S) (Favier Dubois and Scartascini 2012). The morphology and size of

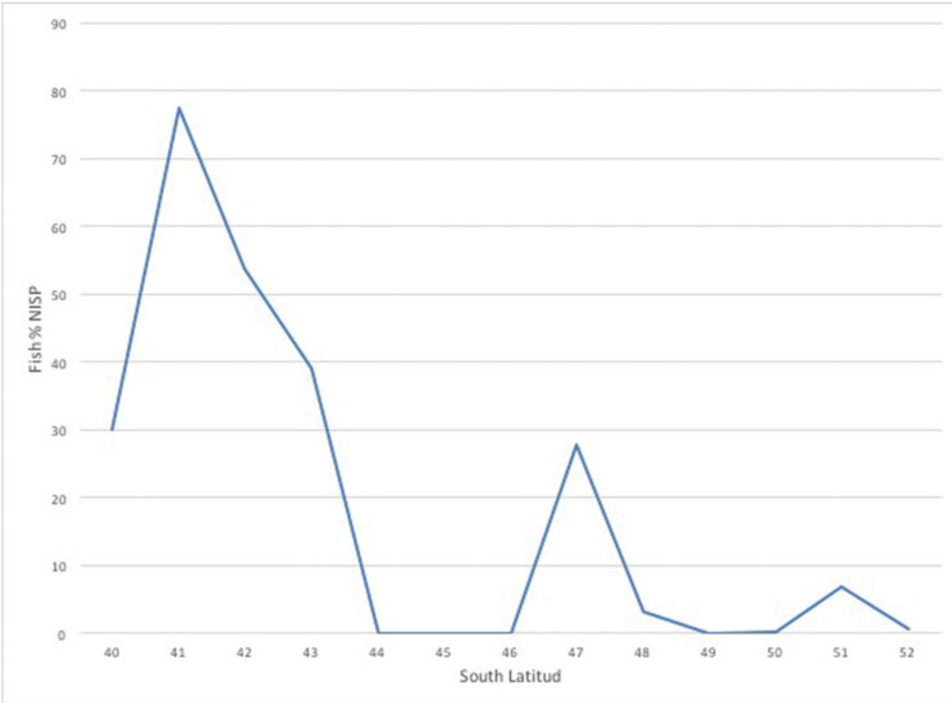

Figure 2. *Latitudinal variations in fish NISP %. No data are available for the intervals 44°, 45°, 46°, and 49°S.*

these otoliths (<4 cm in most cases) makes them very visible in the field, so there may be a bias in favor of these species over others that may be present in sites but they can not be recovered. In no other sector of the Patagonian coast were these kind of surface fishing sites recorded, which may be due among other things to taphonomic problems of visibility and/or recovery. Because of this, it was considered that these sites could overestimate the representation of fish in some areas (e.g., North Patagonia) and underestimate it in other cases. In sum, the samples analyzed here are relatively homogeneous in their nature and origin, which allows for adequate comparisons to be made between them.

As may be deduced from Table 1, the distribution of archaeological sites along the Patagonian coast is discontinuous, something that relates mainly to the lack of information for large sections of this maritime shoreline (e.g., no quantitative data are available from the latitudes of 44°, 45°, 46°, and 49°S). Even with this potential bias, however, a distinctive pattern is observable in the abundance of fish remains on the Patagonian coast. Figure 2 shows the fish%NISP values estimated for each latitude interval (i.e., fish as a percentage of total NISP of all species recovered). Between 40° and 43°S, archaeological sites have on average the largest proportion of fish remains of the entire Patagonian coast. The mean proportion in this latitude interval is 50.2% (with a maximum value of 77.4% and a minimum of 30.1%), whilst in the interval between 47° and 52°S the mean proportion is 8.1% (with a maximum of 28.7% and a minimum of 0.1%). These values would be even lower if data corresponding to Sitio Moreno (47°S), where the proportion of fish is relatively high, were not included (see Table 1).

Nonetheless, this tendency may be the result of the sample size, and not an exclusive tendency of the ichthyoarchaeological record. Taking this into account, a correlation (Spearman rs) was made between the fish NISP and the summation of the rest of the taxa recovered (Σ NISP). This analysis does not show statistically significant results (rho = −0.23, p = .32), which implies that the frequency of fish remains of the Patagonian coast is independent from that of other (non-fish) species.

Likewise, the exploratory analyses show a negative and significant correlation (Spearman rs) (rho = −0.58, p = .00062) between latitude and fish NISP. This suggests that the frequency of fish remains recovered decreases in relation to latitude. Although this tendency could partly be explained by sampling errors and differences in sample size, this same pattern could not be detected by correlating the frequency of other taxa (Σ NISP) with latitude (rho = −0.12, p = .78).

Therefore, a linear regression was performed between latitude and fish NISP to model this relationship quantitatively. With this aim, the absolute frequency of the NISP was converted to logarithms to adapt them to the requirements of this parametrical test (Shapiro W LAT = 0.91, p = .18, Shapiro W Fish = 0.92, p = .28). The result of the regression indicates that latitude is an explanatory factor for the frequency of fish along this coast (r = -0.8, t = -4.94, p = .0004). The results show in addition that the lineal model (Breusch-Pagan: p [homoscedastic] p = .41) successfully predicts that increasing latitude explains 69% (r^2 = 0.69) of the observed pattern in the fish NISP. Figure 3 displays the observed regression and the statistical prediction in relation to the available data.

The lack of quantitative information in the archaeological sites does not allow for an accurate assessment about changes in species diversity along the coast. Qualitative review of the available data shows that in northern Patagonia area (between 39° and 43° S) the Sciaenids, the Sparidae and Serranidae were the most consumed species (Eugenio and Aldazabal 2004; Gomez Otero et al. 2013; Scartascini 2014). In the central and southern part of continental Patagonia (44°–52° S), in contrast, the Nototheniid and some species of hake were the most abundant prey (Bogan et al. 2007; Izeta 1999; Mansur 2007).

Another factor to be considered is the temporal distribution of the fish record. From the 59 observed sites, only 48 could be included in this analysis due to the fact that the rest did not present NISP values and/or chronology. The chronological data show a great dispersion of dates between 5500 and 400 BP. In general however, most of the samples fall within the last 3000 years BP (Figure 4), with a mean age of 2086 ± 1358 BP. Even on a local scale, that is to say dividing age by latitude, the available sets of dates show wide variation, which prevents the recognition of any clear chronological tendencies.

At the regional level, the chronological pattern available shows certain variations between the northern and southern parts of Argentina's Patagonian coast. Most of the available dates correspond to medium latitudes, with 76% (N = 32) of them concentrated between 40° and 43° S. The mean age of sites in this sector of the coast is 2192 BP. At higher latitudes, only 16 dates were surveyed, with a mean age of 1588 BP. These data display some chronological variation in the use of fish between the north and south of the Patagonian coast,

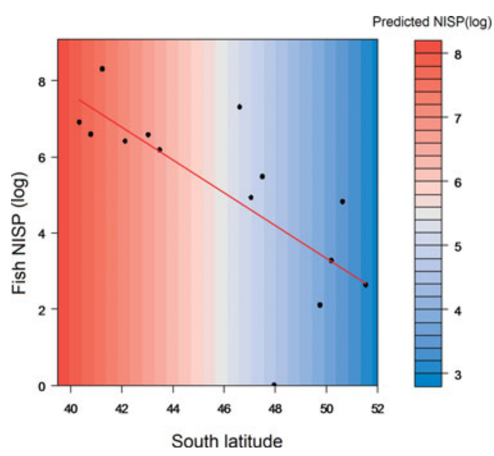

Figure 3. *Observed and modeled regression between Fish NISP Log and latitude.*

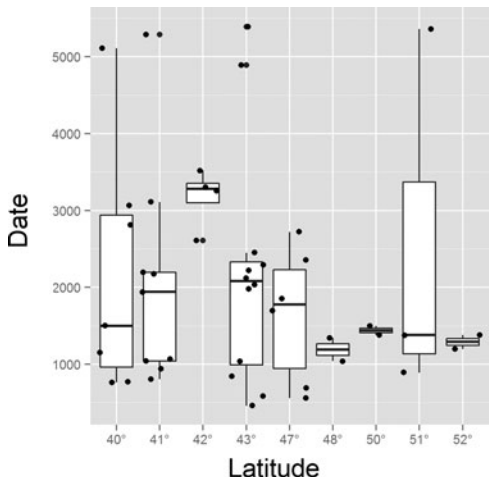

Figure 4. *Box plot and jitter plot, showing the latitudinal tendencies and the dispersion of the individual values for each latitudinal cut grouped on a latitude degree.*

but these differences are not significant ($t = 1.64, p > .05$).

DISCUSSION

The analysis presented above indicates that exploitation of fish along the Patagonian coast was not spatially homogeneous in the past. This pattern does not seem to be linked with taphonomic or formational factors since the samples used come from similar archaeological contexts and correspond in most cases to coastal fish of medium sizes.

First, it could be suggested that the spatial variations identified result from strictly local factors, namely the particular conditions that each coastal section provides for fishing activities. However, a larger scale approach reveals that this variation displays a latitudinal pattern in which the frequency of fish remains in the sampled archaeological sites decreases with increasing (i.e., more southerly) latitude. Although this observation does not imply a complete dismissal of the importance of the local factors (e.g., topography, type of coastline), it does lead us to evaluate the conditions that were most suitable for fishing in a broader environmental sense.

Interestingly, a similar pattern has been observed in relation to the lithic technology employed along the continental Patagonian coast. Cardillo (2011) studied the diversity of the lithic artifacts recovered from this wide area and concluded that the composition of lithic assemblages is structured spatially along a latitudinal environmental gradient. Furthermore, he observed that evidence of fishing technology (i.e., lithic weights) is almost exclusively restricted to the northern and central coast of Patagonia (between 40° and 43°S). This does not imply that it was only on this part of the coast that its prehispanic inhabitants fished since fishing can, in fact, be practiced without any kind of specific technology, as has been amply documented in many ethnographic societies (Von Brant 1984). However, the presence of this kind of specific technology would seem likely to be linked to the development of a systematic and planned system for exploiting marine fish, something that does not seem to occur on other parts of the Patagonian coast.

Significant differences are also evident in the human isotopic record along the Patagonian Atlantic littoral. In a recent paper Moreno et al. (2011) identified a latitudinal pattern in human palaeodiets throughout Patagonia's Atlantic coast. They note a greater intensity in the use of marine resources in the northern part of this coast (specifically on the northern coast of the San Matías Gulf at 40–41°S), with a lower intensity use south of the Santa Cruz River (50°S). The Chubut coast (42–43° S) and the north coast of Santa Cruz province (46–47° S) occupy a position intermediate between the two (Moreno et al. 2011:274).

This observation makes sense, because although the Patagonian coast is a relatively homogeneous geo-environmental unit, the latitudinal variations imply changes in the supply of coastal and terrestrial resources, which would undoubtedly have affected human use of these environments in the past. As mentioned above, the Patagonian Sea presents great spatial variations in regard to its primary productivity and species diversity. In the northern sector, between 40°

and 43°S, there is a transition zone between the two biogeographic provinces, the Argentine and the Magellanic. This process creates a multi-species fishing complex of a high diversity and abundance. In short, there seems to be a relatively tight correspondence between the zone of greater maritime bioproductivity and coastal areas with the highest frequency of fish remains in the ichthyoarchaeological record.

The observed correlations and the interpretation of them should not be taken to mean that only one set of spatial/environmental conditions exists in relation to hunter-gatherer use of the Patagonian Sea's fish resources. Human exploitation of environments and resources is determined by a number of environmental and cultural factors, which operate on different scales (e.g., seasonality, productivity, availability of resources, home ranges, technology). Nonetheless, environmental conditions may have been a factor of great importance in regard to fish exploitation along Patagonia's Atlantic coast. This is independently corroborated by other lines of evidence, such as the distribution of specialized items of fishing technology (Cardillo et al. 2015; Gómez Otero 1996, 2007) and isotopic evidence of human palaeodiet (Favier Dubois et al. 2009; Gómez Otero et al. 2007; Martínez et al. 2012; Moreno et al. 2011).

No clear tendencies could be discerned with regard to temporal variation in the use of fish resources. The available data show only that while fish exploitation along the Patagonian Atlantic coast dates back to the middle Holocene, it was only established in all littoral areas from around 2500 BP. This relatively homogenous temporal aspect to Patagonia's ichthyoarchaeological record is thus in contrast to the heterogeneous spatial distribution described before. However, by considering human palaeodiets, time trends change slightly. Isotopic analyses show that on the northern Patagonian coast (40–42°S) the maritime signal (including fish) has its highest intensity between 4900 and 2200 BP. This dietary signal then decreases in importance to the late Holocene when it exhibits a mixed/continental character (Favier Dubois et al. 2009; Martínez et al. 2012). Along the central coast of Patagonia, however, the data indicate a predominance of mixed diets (marine and inland components) and an increased marine signal in the final Late Holocene (1000–400 BP) (Gómez Otero et al. 2007). Finally, on the north coast of Santa Cruz province (46–48°S) a great variability in the types of diet was detected (including marine, inland, and mixed diets) during the late Holocene and an increased in mixed diets during the final Late Holocene (1000–300 BP) (Zilio et al. 2014).

In sum, the ichthyoarchaeological trends presented here fit relatively well with the available palaeodietary data from the central and southern Patagonia coast. In this sector marine and mixed diets were detected for the last 2000 years BP, which makes sense of the presence of fish remains in this chronology. A similar pattern was observed by Zangrando and Tivoli (2015) in Austral Patagonia and Tierra del Fuego.

Conversely, palaeodietary trends on the northern Patagonian coast suggest a sharp decline in the marine resource consumption after 2200 BP, which contrasts with the increase in fish remains detected there in this period. This could be due to taphonomic biases and the absence of reliable chronological indicators, as observed by Favier Dubois (2013). For example, in the northern coast of Río Negro province (41°S) many fishing sites were dated to the middle Holocene ca. 6000 BP (Favier Dubois and Scartascini 2012). However, as explained above, these assemblages were not included in the analysis presented here because they derive from surface contexts (*M. furnieri* otoliths and net weights mostly). If we take these middle Holocene sites into consideration, then the fishing record would indeed be consistent with the palaeodietary signal detected from this sector of the coast. Although no statistical patterns were detected, this suggests that fish exploitation on the north coast began earlier than on the southern coast of Patagonia.

In sum, the analyses undertaken thus far suggest that fish exploitation on the Patagonian coast was both temporally and spatially variable. Also reverse paths in the exploitation of these resources was observed, when the fishing signal begins to decrease in the north, an increase occurs in the south. It seems likely that the abundance and diversity of fish species was strongly conditioned by environment and latitude and that this could have influenced resource exploitation over time. Moreover, we should not forget that fish exploitation took place in a context of ongoing environmental changes, in both marine and continental areas (e.g., sea-level changes, sea productivity and temperature changes, water deficit on the continent; see Aguirre 2002; Schäbitz 1994, 2003; Schellmann and Radtke 2010). These environmental changes generated significant variations in the distribution and abundance of some marine species, such as the white croaker (see Scartascini and Volpedo 2013), which led to major changes in the exploitation of this resource in the past (Scartascini et al. 2009).

Taken together all lines of evidence suggest significant variations between northern and southern Patagonia. These variations do not seem to be limited to fish exploitation only, but also in the broader economical and technological system. To assess the reasons for these changes is beyond the scope of this paper, but this scenario invites us to ask whether these latitudinal changes could also be linked to other social or cultural factors. In fact, the archaeological information generated in recent years shows signs of regionalization and human mobility decreased in certain areas of Patagonia (Barrientos and Perez 2002; Borrero 1989–1990; Borrero et al. 2009; Cardillo 2011, among others). In pre-Europeans times, linguistics, ethno-historical and genealogical information indicates the existence of at least two distinct social groups in continental Patagonia (Casamiquela 1965). The northern Tehuelches (Gününa Kena) inhabited northern Patagonia and the southern part of the Pampas to the Chubut river (43°S) and the southern Tehuelches (Aónik'enk) occupied the area from the Chubut river (43°S) to the Magellan Strait (52°S) (Casamiquela 1965). Interestingly, the linguistic and ethnohistoric data shows substantial differences between those social groups whose differences fit relatively well with the latitudinal model about fish consumption presented in this paper. However, we have not yet a clear picture about the timing and scale of these social processes, which seem to be a late phenomenon (Final Late Holocene) (see Nacuzzi 1998). In addition, demographic data suggest a population increase in North Patagonia during the Middle Holocene (between 7000 and 5000 years BP) (Perez et al. 2016), at which time the increase in marine adaptations (with a high consumption of fish) is observed in this sector. Taking into account this set of data, it could be stated as a hypothesis that the population increase may have been one of the coastal adaptation triggers documented in north Patagonia, in the context of an intensification strategy (*sensu* Binford 2001).

These ideas are certainly promising, but in this instance they are only one possibility among many others that should be explored in greater detail when more information becomes available. The broad discussion underneath this matter concerns the overlap or interplay between environmental conditions and human population dynamics and their implications in the subsistence strategy in this area of Patagonia Argentina. So far the information available shows big differences between the north and south of the Patagonian coast in reference to fish resources consumption and other aspects of the human economy and technology.

FINAL CONSIDERATIONS

The work reported here shows that the exploitation of fish resources was variable in Patagonia, with dissimilar situations at different times and in different places (high dependence on fish, low dependence on fish, complementarity with other resources, etc.). The latitudinal model proposed fits quite well with the environmental conditions of the Patagonian Sea and the cultural information currently available. This is the first step toward gaining a better idea about how fishing fit within the broader economy in this particular area of South America. The information generated in this article allows us to contribute to the discussion about human use of the environment and resources in the Patagonian coast and raise some ideas that should be discussed in detail in future work.

In summary, the apparent homogeneity evident on Argentina's Patagonian desert coast covers up and overlaps with a multiplicity of human responses to a number of environmental and cultural factors. Finally, the different scales of analysis considered here provide evidence of diverse patterns of prehistoric resource use that now require further investigation to achieve deeper insights into past hunter-gatherer use of the Patagonian coast and the strategies and techniques people employed to access its resources.

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