Quaternary International 301 (2013) 123–134

Contents lists available at SciVerse ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

Chronology and human settlement in northeastern Patagonia (Argentina): Patterns of site destruction, intensity of archaeological signal, and population dynamics

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A R T I C L E I N F O

Article history:
Available online 27 March 2013

A B S T R A C T

Temporal frequency distributions are used to assess the chronology and continuity of human occupation at different spatial scales, differential landscape use and demographic patterns throughout time. These issues were addressed by applying the summed of radiocarbon probability distributions method to the north-eastern sector of Patagonia (Argentina). This sector was divided into three microregions: the lower course of the Colorado River, the mouth and the middle and lower course of Negro River, and the north coast of San Matías Gulf. Differences in the chronology of the occupations are observed when considering individually the three micro-regions. Also, differences are recorded regarding the chronological pattern obtained from coastal and inland sectors. These differences are mainly the outcome of specific geomorphological processes operating in different sectors of landscape that generated taphonomic bias. Sites were differentially impacted by taphonomic factors and the recognition of older sites than Middle and Late Holocene is difficult. Despite the detection of taphonomic biases, it is proposed that the higher intensity of the archaeological signal for the Final Late Holocene (ca. 600–400 cal BP) would be the result of higher population densities. It is suggested that chronological patterns obtained by temporal frequency distributions should be strengthened by independent evidence provided by qualitative information on the reorganization of hunter–gatherer societies (e.g.; changes in burial practices, subsistence, technology, etc.), indispensable to better evaluate the increase in population size and prehistoric demography.

1. Introduction

The sum of radiocarbon probability distributions are commonly used as a tool in order to interpret human occupational trends within a region; to explore abandonment, continuity and/or discontinuity of human occupation of certain areas and its relationship with neighboring ones; to statistically compare them with paleoenvironmental data; to explore demographic responses to climatic changes; and to analyze occupational histories at areal and regional scales, among others (Rick, 1987; Gamble et al., 2005; Holdaway et al., 2005; Shennan and Edinborough, 2007; Surovell and Brantingham, 2007; Buchanan et al., 2008; Hiscock, 2008; Smith and Ross, 2008; Fanning et al., 2009; Peros et al., 2010; Steele, 2010; Williams, 2012, among others). Temporal frequency distributions, and the intensity of the archaeological signal that is inferred from the former, have also opened up discussions on problems derived from taphonomic bias related to geomorphological processes affecting the archaeological record and its differential preservation, as well as from scientific bias related to the intensive treatment of specific archaeological problems within specific periods and places (Surovell and Brantingham, 2007; Hiscock, 2008; Holdaway et al., 2008; Fanning et al., 2009; Surovell et al., 2009; Ballenger and Mabry, 2011).

Radiocarbon date frequency distributions have been discussed in different regions of Argentina (e.g., Cuyo, Patagonia, and Pampa) for hunter–gatherer contexts (Berón et al., 2007; Barberena, 2008; Barrientos, 2009; Neme and Gil, 2009, 2010; García, 2010, among others). However, so far, contributions of this kind have not been performed in northeastern Patagonia where radiocarbon dates show a human occupation from the Middle Holocene (ca. 7200 cal BP) to European contact (ca. 200 cal BP). The aim of this paper is to evaluate the chronology of human occupation in the northeastern sector of Patagonia, which includes the lower course of the Colorado River, the mouth and the middle and lower course of Negro River, and the north coast of San Matías Gulf (Fig. 1). Temporal frequency distributions are analyzed in order to understand the intensity of the archaeological signal during the Middle and Late

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http://dx.doi.org/10.1016/j.quaint.2013.03.027

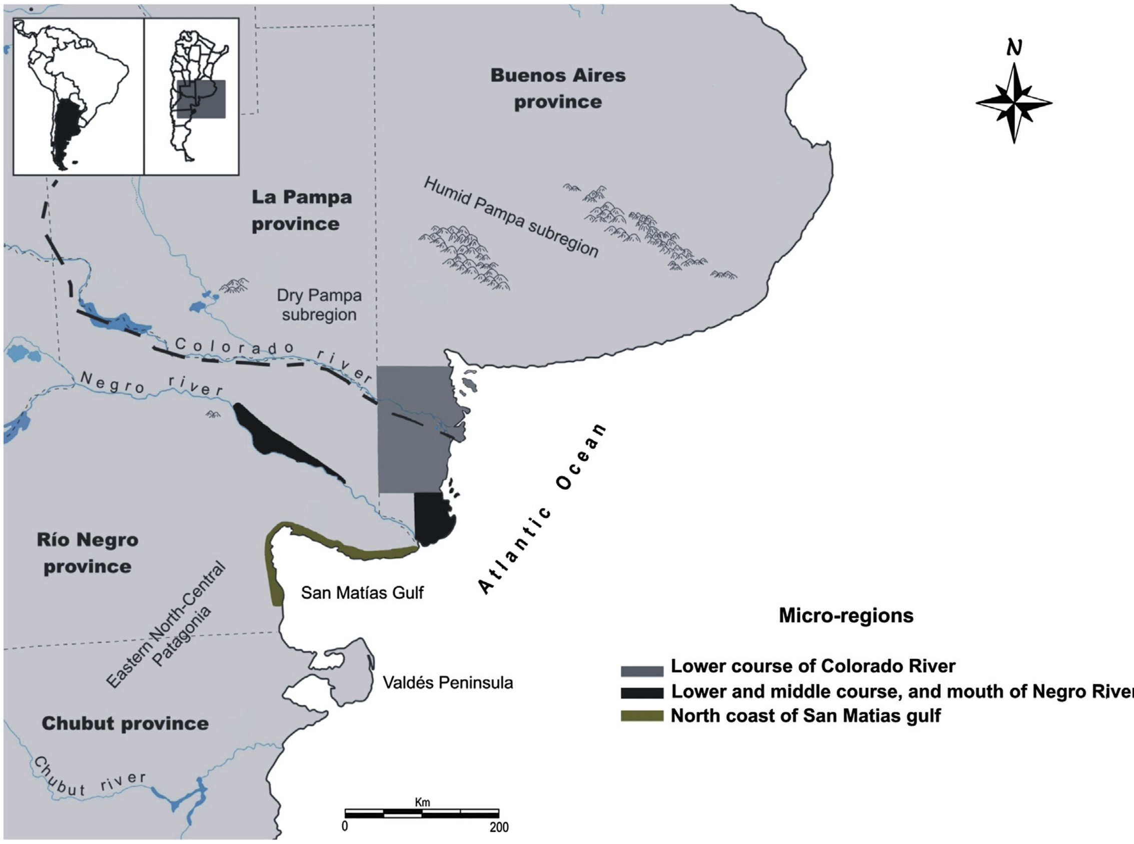

Fig. 1. Northeastern Patagonia and the three selected micro-regions.

Holocene in order to evaluate demographic tendencies and landscape use by hunter–gatherer groups. Particularly, based on data obtained from this region, the differences recorded in archaeological signals as the result of factors linked to paleoenvironments and population dynamics, differential productivity in specific sectors of the landscape, and geomorphological agents that influenced temporal frequency distributions are discussed. Whether archaeological research development (e.g., intensity of investigations in each area, systematic and time-sustained research programs, etc.) had an influence on the obtained temporal patterns is also evaluated.

1.1. Main environmental and geomorphological characteristics of northeastern Patagonia

The study area comprises a sector of northeastern Patagonia (38°–41° S; 62°–64° W), and was divided into three micro-regions: the lower course of Colorado River, the mouth, and the middle and lower course of Negro River, and the north coast of San Matías Gulf (Fig. 1). A micro-region (*sensu* Aschero, 1988) comprises zones with differentiated topographic, vegetal, animal, and mineral resources. Although some similarities exist (all belong to the *Diagonal Árida*; Abraham de Vázquez et al., 2000), the three micro-regions have distinctive micro-environmental and geomorphological characteristics.

The Colorado River cuts across Argentina, from the Andes to the Atlantic Ocean (Fig. 1). The lower course is located in an ecotone of the Pampean–Patagonic transition characterized by arid steppe, a dry temperate climate with an average temperature of 14.8 °C and an average annual rainfall of ca. 460 mm (Morello, 1958; Villamil and Scoffield, 2003). Vegetation corresponds to the *Caldén* district, *Espinal* province, but there are also flora communities of the *Monte* province (Morello, 1958; Páez et al., 2001). Zoogeographically, the area is located in the Patagonic subregion, Patagonic district (Ringuelet, 1961). The river ends in a delta whose estuary is characterized by a high biological productivity. The old delta is associated with a complex system of paleochannels and old floodplains where small pebbles are distributed. The coast has a gentle slope, extended low beaches, and no cliffs. Most of the fluvial and marine geomorphological features are covered by recent eolian mantles (see discussion in Martínez and Martínez, 2011 and references therein).

The Negro River is the largest river valley of Patagonia and runs from the Andes in the west to the southeast where it flows into the Atlantic Ocean (Fig. 1). It is characterized by an arid to semiarid temperate climate, with an average temperature of 14.2 °C, and 300 mm annual rainfall in the middle valley, gradually rising to ~500 mm at the river mouth (Páez et al., 2001). Phytogeographically, the area belongs to the Neotropical region, *Chaqueño* domain, and to the ecotone between the *Monte* and *Espinal* provinces (Morello, 1958). Zoogeographically, the valley of Negro River belongs to the Andean Patagonic sub-region, Patagonic domain (Ringuelet, 1961), but its proximity to the Central domain gives ecotonal characteristics to this area. In the lower course of the Negro River, in its estuary, there is an extended wetland with a high primary productivity and biodiversity (Lini et al., 2005). Most of the modern bed and abandoned paleochannels are covered by large cobbles (Luchsinger, 2006; Prates, 2008). The coast is characterized by active cliffs that constitute a receding coastline. Towards the inactive cliffs, fixed and mobile dunes are observed, and temporary lagoons are frequently present (Del Río et al., 2005). Near the river mouth, there are abrasion platforms, spits, inactive old cliffs, and well developed beaches, covered by modern fluvial sediments (see Del Río et al., 2005 and references therein).

The area of San Matías Gulf (Fig. 1) is characterized by a semi-arid, temperate climate, with an average temperature of 12 °C and an average annual rainfall between 100 and 350 mm. Vegetation corresponds to the *Monte* province, with a dominant shrubby steppe (Morello, 1958) and the faunal communities belong to the Andine Patagonic sub-region, Patagonic domain (Ringuelet, 1961). Two sectors are distinguished according to the orientation and general characteristics of the coast. The northern coast runs east-west, with an old dissected fluvial plateau interrupted by topographic depressions. It is characterized by active cliffs and abraded platforms that allow for the accumulation of molluscs and other invertebrates. The northern coast has a high biodiversity and marine bioproductivity, freshwater springs within dunes, abundant raw material sources located in secondary deposits of *Tehuelche* pebbles (Favier Dubois et al., 2006), and favorable conditions for pinniped beaching. Marine terraces are covered by eolian dunes and mantles (see Favier Dubois et al., 2009; Favier Dubois and Kokot, 2011 and references therein). The western coast runs North-South, and it is characterized by dunes, sandspits and terraces in the northern area, as well as cliffs and sandspits in its southern area (Favier Dubois et al., 2009).

Remarkable geomorphological differences are observed between the littoral coastal portions ranging from the lower course of the Colorado River to the San Matías Gulf (Fig. 1). Whereas the former area is characterized by the absence of cliffs and a gentle slope and extended low beaches, the latter presents an alternating pattern of low-lying and abrupt coastal cliffs. This differential coastal configuration conditioned the geomorphological effects of Middle and Late Holocene marine transgressions and regressions. In the lower course of the Colorado River marine geoforms ca. 7000 BP were identified ~8 km inland (Weiler, 1983: 399, Fig. 2). By ca. 1800 BP, intertidal and subtidal zones, ancient estuaries, and coastal lagoons developed 4 km from the present coast. In this location, at the top of the same stratigraphic sequence, archaeological sites chronologically located at ca. 1000–800 BP are found in aeolian mantles (Martínez and Martínez, 2011). In the San Matías Gulf, the coast underwent important changes in its configuration through time. During the transgressive maximum within the Middle Holocene period (ca. 6000 BP), the ocean seeped into ancient Pleistocene spits, channels were formed among these, and afterwards they were filled with sediment. By ca. 1000 BP a rectification of the littoral coast was produced under a higher sea level. The coastal transformation occurred ~1 km from the current Atlantic coast (see Fig. 4 in Favier Dubois and Kokot, 2011: 107).

1.2. Paleoclimatic characteristics of northeastern Patagonia

Paleoclimatic reconstructions are still scarce for northeastern Patagonia, and there is an imbalance in the different proxy data generated for the three micro-regions (Schäbitz, 1994, 2003; Luchsinger, 2006; Stoessel et al., 2008; Fernández et al., 2011; Martínez and Martínez, 2011; Fernández, 2012; Marcos et al., 2012). Sedimentological and palynological analyses for the last 6000 years indicated that the climate in northeastern Patagonia would have been arid and semiarid. The Middle Holocene was characterized by arid conditions and eolian morphodynamic processes. The Late Holocene would have been arid to semiarid, with a higher rainfall frequency, lake expansion, and a marked seasonality towards the end of this period (Schäbitz, 1994, 2003). Based on geomorphologic, sedimentary and stratigraphic data, the existence of intense morphogenetic processes in the lower course of the Colorado River at ca. 3000–1000 BP has been proposed. Towards ca. 1000–400 BP, there were periods of landscape stability and pedogenesis, followed by erosive processes and landscape reactivation (Martínez and Martínez, 2011). In the north coast of San Matías Gulf, palynological studies show arid conditions between ca. 7500 and 4000 BP, semiarid conditions since ca. 3000 BP, and arid pulses in ca. 1000 BP, followed by a humid pulse (Marcos et al., 2012). Taking into account the chronology considered in this paper, two main climatic events could have taken place in this area: the Medieval Climatic Anomaly (MCA; A.D. 1080–1250), and the Little Ice Age (LIA; A.D. 1340–1640) (Villalba, 1994).

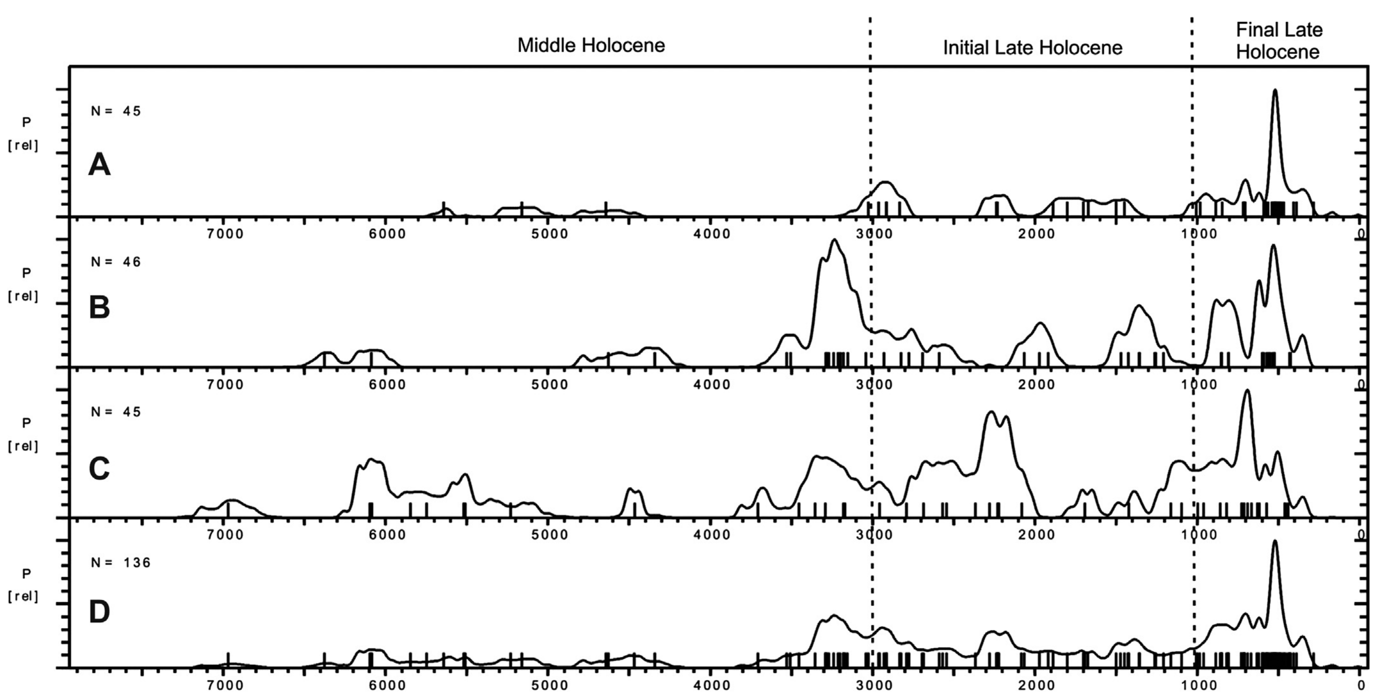

Fig. 2. Temporal frequency distribution by micro-regions. A) Lower course of the Colorado River, B) Lower and middle courses and mouth of Negro River, C) North coast of San Matías Gulf, D) Northeastern Patagonia.

2. Materials and methods

Based on geomorphological and paleoclimatic changes described above (Schäbitz, 1994, 2003; Martínez and Martínez, 2011; Marcos et al., 2012), as well as those related to significant cultural changes and social reorganization recognized for Pampa and Northern Patagonia hunter–gatherer populations (Berón, 2007; Martínez, 2008–2009; Prates, 2008; Politis, 2008; Favier Dubois et al., 2009, among others), the periods considered in this paper has been established as follows: Middle Holocene: ca. 6500–3000 BP; Initial Late Holocene: ca. 3000–1000 BP; and Final Late Holocene: ca. 1000–250 BP.

The chronology of each micro-region was analyzed separately, taking into account the radiocarbon ages that have been published. Secondly, all radiocarbon values were integrated, in order to compare the different micro-regions and interpret temporal frequency distributions at a larger spatial scale: northeastern Patagonia. A bibliographic search was done in order to get chronological data for each micro-region, which was standardized by considering the following variables: site name and/or collection, laboratory code, dated material, radiocarbon ^{14}C age with standard deviation, and the calibrated age with two sigma. Both standard and AMS radiocarbon dates were considered. The radiocarbon dates whose ages were considered as accepted for the authors in the published papers were taken from the analysis. In case there were dates sampled from both shell and charcoal in the same context, the latter was chosen, in order to avoid correction for reservoir effect (Favier Dubois, 2009), and sample overestimation. Reservoir effect was calculated (Favier Dubois, 2009) and reported for samples from one micro-region, the north coast of San Matías Gulf (see Favier Dubois and Kokot, 2011). When an individual (e.g., a primary burial) or bone element was dated more than once, the weighted mean of the obtained values were considered in order to avoid sample overestimation.

The analysis involves 136 radiocarbon dates, of which 108 (79.4%) correspond to AMS and 28 (20.6%) to standard dating methods. Considering each micro-region, 45 radiocarbon dates were recorded for the lower course of the Colorado River, mostly coming from human bones ($n = 29$), and in lesser account, from animal remains ($n = 16$) (Table 1). For the lower and middle course and the mouth of Negro River, 46 radiocarbon dates were recorded, most of them from human bones ($n = 24$), followed by animal remains ($n = 10$), shell ($n = 5$), and charcoal ($n = 7$) (Table 2). Finally, for the north coast of San Matías Gulf, 45 radiocarbon dates were recorded, corresponding to human remains ($n = 14$), charcoal ($n = 16$), shell ($n = 4$), otoliths ($n = 7$), and animal remains ($n = 4$) (Table 3).

Table 1
Radiocarbon dates from the Lower course of the Colorado River.

Archaeological site/collection	Lab. code	Dated material	^{14}C years BP	Cal years BP	Reference
Collection Museo La Plata	AA82513	*Homo sapiens*-bone	1086 ± 45	809–1055	Gordón, 2011
Cantera Rodado Villalonga	AA91549	*Homo sapiens*-bone	4889 ± 58	5330–5710	Martínez et al., 2012
Cantera Rodado Villalonga	AA91550	*Homo sapiens*-bone	4502 ± 56	4874–5288	Martínez et al., 2012
Cantera Rodado Villalonga	LP2452	*Homo sapiens*-bone	4100 ± 80	4297–4825	Martínez et al., 2012
Don Aldo 1	Ua22560	*Homo sapiens*-bone	780 ± 45	567–737	Prates et al., 2006
El Puma 2	AA88421	*Homo sapiens*-bone	1548 ± 51	1301–1517	Martínez and Martínez, 2011
El Puma 4	AA88420	*Lama guanicoe*-bone	1862 ± 51	1573–1871	Martínez and Martínez, 2011
El Puma 3	AA 96142	*Lama guanicoe*-bone	2209 ± 48	2002–2311	Martínez et al., 2012
El Puma 3	AA96143	*Lama guanicoe*-bone	2219 ± 47	2006–2319	Martínez et al., 2012
El Tigre	AA81830	*Lama guanicoe*-bone	437 ± 43	324–517	Martínez, 2008–2009
El Tigre	Ua22561	*Lama guanicoe*-bone	455 ± 45	327–532	Martínez et al., 2005
El Tigre	AA81834	*Lama guanicoe*-bone	536 ± 43	488–623	Martínez, 2008–2009
El Tigre	AA70565	*Percichthys* sp.-bone	930 ± 47	693–918	Martínez et al., 2005
La Petrona – LP1	AA43127	*Homo sapiens*-bone	314 ± 45	154–467	Martínez, 2004
La Petrona – LP1	AA43126	*Homo sapiens*-bone	352 ± 51	298–492	Martínez, 2004
La Petrona – LP2	AA43124	*Homo sapiens*-bone	481 ± 37	339–539	Martínez, 2004
La Petrona – LP2	AA43125	*Homo sapiens*-bone	770 ± 49	563–736	Martínez, 2004
La Petrona – LP3	AA43122	*Homo sapiens*-bone	436 ± 39	326–521	Martínez, 2004
La Petrona – LP4	AA70564	*Homo sapiens*-bone	248 ± 39	0–325	Martínez et al., 2009
La Primavera	AA70560	*Homo sapiens*-bone	2728 ± 48	2722–2916	Martínez et al., 2009
La Primavera	GX28772	*Homo sapiens*-bone	2800 ± 60	2748–2991	Bayón et al., 2004
La Primavera	AA70561	*Homo sapiens*-bone	2882 ± 49	2786–3136	Martínez et al., 2009
La Primavera	AA91547	*Lama guanicoe*-bone	2805 ± 50	2754–2960	Stoessel, 2012a
La Primavera	AA91548	*Lama guanicoe*-bone	2839 ± 50	2761–3058	Stoessel, 2012a
Loma Ruiz 1	AA53331	*Lama guanicoe*-bone	1615 ± 50	1342–1552	Martínez, 2008–2009
Loma Ruiz 1	AA88418	*Lama guanicoe*-bone	1749 ± 64	1413–1776	Martínez and Martínez, 2011
Loma Ruiz 1	AA88419	*Lama guanicoe*-bone	1775 ± 66	1421–1819	Martínez and Martínez, 2011
Loma Ruiz 1	AA53332	*Lama guanicoe*-bone	1935 ± 44	1708–1925	Martínez, 2008–2009
Paso Alsina 1 – E1	AA63958	*Homo sapiens*-bone	497 ± 43	340–549	Martínez et al., 2007
Paso Alsina 1 – E10a	AA59696	*Homo sapiens*-bone	504 ± 34	474–545	Martínez et al., 2007
Paso Alsina 1 – E10b	AA59694	*Homo sapiens*-bone	483 ± 34	343–538	Martínez et al., 2007
Paso Alsina 1 – E2	AA59695	*Homo sapiens*-bone	452 ± 35	329–524	Martínez et al., 2007
Paso Alsina 1 – E2c	AA63959	*Homo sapiens*-bone	471 ± 43	329–543	Martínez et al., 2007
Paso Alsina 1 – E3	AA63960	*Homo sapiens*-bone	570 ± 44	499–631	Martínez et al., 2007
Paso Alsina 1 – E4	AA63961	*Homo sapiens*-bone	516 ± 44	460–555	Martínez et al., 2007
Paso Alsina 1 – E5	AA63963	*Homo sapiens*-bone	448 ± 43	326–526	Martínez et al., 2007
Paso Alsina 1 – E5	AA63962	*Homo sapiens*-bone	465 ± 43	328–539	Martínez et al., 2007
Paso Alsina 1 – E6	AA63964	*Homo sapiens*-bone	476 ± 43	331–544	Martínez et al., 2007
Paso Alsina 1 – E7	AA63965	*Homo sapiens*-bone	485 ± 43	334–546	Martínez et al., 2007
Paso Alsina 1 – E8	AA70562	*Homo sapiens*-bone	465 ± 41	329–538	Martínez et al., 2007
Paso Alsina 1 – E9	AA63966	*Homo sapiens*-bone	446 ± 42	326–523	Martínez et al., 2007
San Antonio 1	AA81832	*Lama guanicoe*-bone	773 ± 44	566–733	Martínez, 2008–2009
San Antonio 2	AA81831	*Lama guanicoe*-bone	988 ± 44	749–931	Martínez, 2008–2009
San Antonio 2	AA85152	*Homo sapiens*-bone	1053 ± 53	796–1045	Martínez and Martínez, 2011
San Antonio 2	AA77966	*Lama guanicoe*-bone	764 ± 45	564–731	Stoessel et al., 2008

Table 2
Radiocarbon dates for the Lower and Middle courses and Mouth of the Negro River.

Archaeological site/collection	Lab. code	Dated material	^{14}C years BP	Cal. years BP	Reference
Angostura 1	AA62793	*Rhea americana*-bone	405 ± 46	322–499	Prates, 2008
Angostura 1	AA2551	*Lama guanicoe*-bone	938 ± 45	729–915	Prates, 2008
Collection Museo La Plata	AA82514	*Homo sapiens*-bone	2989 ± 52	2893–3316	Gordón, 2011
Collection Museo La Plata	AA82515	*Homo sapiens*-bone	2502 ± 50	2354–2709	Gordón, 2011
Collection Museo La Plata	AA82516	*Homo sapiens*-bone	484 ± 43	334–546	Gordón, 2011
Collection Museo La Plata	AA82517	*Homo sapiens*-bone	3002 ± 52	2950–3322	Gordón, 2011
Collection Museo La Plata	AA82518	*Homo sapiens*-bone	3272 ± 53	3338–3576	Gordón, 2011
Collection Museo La Plata	AA82519	*Homo sapiens*-bone	3067 ± 52	3006–3361	Gordón, 2011
Collection Museo La Plata	AA82520	*Homo sapiens*-bone	527 ± 44	469–620	Gordón, 2011
Collection Museo La Plata	AA82521	*Homo sapiens*-bone	493 ± 44	337–549	Gordón, 2011
Collection Museo La Plata	AA82522	*Homo sapiens*-bone	591 ± 44	504–638	Gordón, 2011
Conchero El Lobito	LP938	Pinniped-bone	3210 ± 60	3213–3555	Eugenio and Aldazabal, 2004
Conchero Las Olas 1-Piche 1	LP1084	Pinniped-bone	1500 ± 40	1291–1405	Eugenio and Aldazabal, 2004
Conchero Las Olas 2-Piche 4	LP1163	Charcoal	1960 ± 50	1713–1982	Eugenio and Aldazabal, 2004
Conchero Las Olas 11	LP1058	Pinniped-bone	2810 ± 50	2754–2967	Eugenio and Aldazabal, 2004
Conchero Las Olas 5 (sector 3)	LP1158	Shell	570 ± 40	502–628	Eugenio and Aldazabal, 2004
El Haras I (conchero)	LP1224	Pinniped-bone	3070 ± 70	2992–3377	Eugenio and Aldazabal, 2004
El Haras I (conchero)	LP1200	Shell	2810 ± 40	2766–2958	Eugenio and Aldazabal, 2004
El Caiquén (Sitio 2 - conchero)	LP s/n°	Shell	3910 ± 50	4094–4419	Sanguinetti de Bórmida, 2005
La Eloisa (Sitio 1 - conchero)	LP1168	Shell	1340 ± 40	1089–1294	Sanguinetti de Bórmida, 1999
La Eloisa. Entierro	LP s/n°	*Homo sapiens*-bone	1310 ± 100	964–1328	Sanguinetti de Bórmida, 1999
La Serranita (Sitio A - conchero)	LP s/n°	Shell	5580 ± 70	6185–6473	Sanguinetti de Bórmida, 1999
La Serranita (Sitio C)	LP s/n°	*Homo sapiens*-bone	4080 ± 70	4291–4816	Sanguinetti de Bórmida, 1999
La Serranita 2 (Sitio A-conchero)	LP1138	Charcoal	5300 ± 60	5901–6195	Eugenio and Aldazabal, 2004
La Victoria	AA62796	*Homo sapiens*-bone	868 ± 48	668–899	Prates, 2008
La Victoria	AA70563	*Homo sapiens*-bone	928 ± 39	726–908	Prates, 2008
Laguna del Juncal (RN1)	AA72628	*Homo sapiens*-bone	3009 ± 48	2959–3319	Bernal et al., 2008
Laguna del Juncal (RN2)	AA72630	*Homo sapiens*-bone	3070 ± 49	3010–3362	Bernal et al., 2008
Laguna del Juncal (RN3)	AA72632	*Homo sapiens*-bone	2600 ± 47	2370–2759	Bernal et al., 2008
Laguna del Juncal (RN4)	AA72634	*Homo sapiens*-bone	2642 ± 47	2488–2788	Bernal et al., 2008
Laguna del Juncal (RN5)	AA72627	*Homo sapiens*-bone	404 ± 40	324–498	Bernal et al., 2008
Laguna del Juncal (RN6)	AA72631	*Homo sapiens*-bone	512 ± 41	468–552	Bernal et al., 2008
Loma de los Muertos 1	AA81827	*Homo sapiens*-bone	2088 ± 46	1882–2121	Prates et al., 2010a
Loma de los Muertos 1	AA81829	*Homo sapiens*-bone	2718 ± 47	2717–2873	Prates et al., 2010a
Loma de los Muertos 1	AA81828	*Homo sapiens*-bone	3027 ± 48	2985–3327	Prates et al., 2010a
Loma de los Muertos 1	AA83516	*Dusicyon avus*-bone	2972 ± 50	2886–3242	Prates et al., 2010b
Loma de los Muertos 1	LP2005	*Lama guanicoe*-bone	520 ± 90	323–646	Prates et al., 2010b
Negro Muerto	AA62794	*Lama guanicoe*-bone	398 ± 46	320–497	Prates, 2008
Negro Muerto	AA62795	*Lama guanicoe*-bone	483 ± 43	334–545	Prates, 2008
San Blas (SB1)	AA72636	*Homo sapiens*-bone	593 ± 40	507–635	Bernal et al., 2008
San Blas (SB2)	AA72629	*Homo sapiens*-bone	1461 ± 46	1194–1402	Bernal et al., 2008
San Carlos	AA64294	Charcoal	2015 ± 38	1822–1995	Luchsinger, 2006
380	AA64288	Charcoal	1519 ± 50	1288–1513	Luchsinger, 2006
498	AA64292	Charcoal	1459 ± 41	1267–1387	Luchsinger, 2006
315	AA64290	Charcoal	1339 ± 48	1083–1295	Luchsinger, 2006
284	AA64293	Charcoal	870 ± 39	672–895	Luchsinger, 2006

Table 3
Radiocarbon dates for the North coast of San Matías Gulf.

Archaeological site/collection	Lab. code	Dated material	^{14}C years BP	Cal. years BP	Reference
Bahía de San Antonio	AA77304	Charcoal	5290 ± 39	5912–6178	Favier Dubois, 2009
Bahía de San Antonio	AA81726	Bone	4794 ± 59	5321–5590	Favier Dubois and Scartascini, 2011
Bahía de San Antonio	LP1900	*Micropogonias furnieri*-otoliths	4560 ± 80	4872–5442	Favier Dubois, 2009
Bahía de San Antonio	LP1964	*Micropogonias furnieri*-otoliths	3210 ± 70	3172–3560	Favier Dubois and Scartascini, 2011
Bahía de San Antonio	LP2235	*Micropogonias furnieri*-otoliths	890 ± 80	662–922	Favier Dubois and Scartascini, 2011
Bahía Final 6	AA64772	Charcoal	740 ± 40	560–720	Favier Dubois, 2009
Bahía Final 6	AA64773	Charcoal	3430 ± 43	3474–3812	Favier Dubois, 2009
Bahía Final 6 - Costa	AA75707	*Homo sapiens*-bone	796 ± 45	570–760	Favier Dubois et al., 2009
Bahía Creek	LP2317	Shell	5310 ± 60	5907–6200	Favier Dubois and Scartascini, 2011
Bahía Creek	LP2321	*Micropogonias furnieri*-otoliths	5110 ± 80	5607–5938	Favier Dubois and Scartascini, 2011
Bahía Rosas	AA77298	Charcoal	3985 ± 41	4194–4519	Favier Dubois, 2009
Bajada de los Pescadores	AA81730	Charcoal	2197 ± 38	1998–2307	Borella and Cruz, 2012
Bajada de los Pescadores	AA88056	Penguin-bone	2601 ± 51	2367–2760	Borella and Cruz, 2012
Barranca de los Concheros	AA64774	Charcoal	2839 ± 42	2774–1996	Favier Dubois, 2009
Barranca de los Concheros	AA74746	Charcoal	2984 ± 50	2893–3257	Favier Dubois, 2009
Barranca de los Concheros	AA74748	Charcoal	2482 ± 49	2349–2704	Favier Dubois, 2009
Barranca de los Concheros	AA64775	Charcoal	1772 ± 36	1537–1711	Favier Dubois, 2009
Caleta de los Loros	AA77300	Charcoal	2108 ± 35	1902–2124	Favier Dubois, 2009
Centro Minero	AA75712	*Homo sapiens*-bone	689 ± 44	554–666	Favier Dubois et al., 2009
Centro Minero	AA75711	*Homo sapiens*-bone	1513 ± 48	1286–1509	Favier Dubois et al., 2009

(*continued on next page*)

Table 3 (*continued*)

Archaeological site/collection	Lab. code	Dated material	^{14}C years BP	Cal. years BP	Reference
Bajo de La Quinta	LP2016	*Mytilus edulis*-shell	1070 ± 60	796–1056	Favier Dubois and Kokot, 2011
Bajo de La Quinta	AA81727	Charcoal	942 ± 37	735–908	Favier Dubois and Kokot, 2011
Bajo de La Quinta	LP1923	*Aulacomya ater*-shell	1040 ± 60	766–1051	Favier Dubois and Kokot, 2011
Bajo de La Quinta	AA81728	Charcoal	804 ± 37	652–743	Favier Dubois and Kokot, 2011
Bajo de La Quinta	LP1958	Charcoal	540 ± 80	328–655	Favier Dubois and Kokot, 2011
Bajo de La Quinta	LP1926	Charcoal	450 ± 80	307–549	Favier Dubois and Kokot, 2011
Bajo de La Quinta	LP1904	*Micropogonias furnieri*-otoliths	6080 ± 80	6672–7156	Favier Dubois and Scartascini, 2011
Bajo de La Quinta	LP2312	*Micropogonias furnieri*-otoliths	4980 ± 90	5472–5903	Favier Dubois and Scartascini, 2011
Bajo de La Quinta	LP2456	*Micropogonias furnieri*-otoliths	4800 ± 70	5319–5596	Favier Dubois and Scartascini, 2011
Bajo de La Quinta – CH	AA81730	Charcoal	2197 ± 38	1998–2307	Favier Dubois and Kokot, 2011
Bajo de La Quinta – CH	AA75710	*Homo sapiens*-bone	1173 ± 45	934–1170	Favier Dubois et al., 2009
Bajo de La Quinta – CH	AA70721	*Homo sapiens*-bone	1225 ± 47	966–1233	Favier Dubois et al., 2007
Bajo de La Quinta – Sector 1	AA64777	*Homo sapiens*-bone	3077 ± 54	3008–3368	Favier Dubois et al., 2007
Bajo de La Quinta – Sector 1	AA75708	*Homo sapiens*-bone	2458 ± 50	2340–2702	Favier Dubois et al., 2009
Bajo de La Quinta – Sector 1. Conchero	LP1878	*Aulacomya ater*-shell	3000 ± 90	2871–3347	Favier Dubois and Kokot, 2011
Bajo de La Quinta – Sector 3	AA75709	*Homo sapiens*-bone	771 ± 45	565–733	Favier Dubois et al., 2009
El Buque Sur	AA70720	*Homo sapiens*-bone	2195 ± 49	1994–2310	Favier Dubois et al., 2007
El Buque Sur	AA70719	*Homo sapiens*-bone	2300 ± 49	2140–2348	Favier Dubois et al., 2007
Isla Lobos	AA75713	*Homo sapiens*-bone	2670 ± 37	2543–2844	Favier Dubois et al., 2009
Mojón Oliveira	AA77306	Charcoal	715 ± 33	560–673	Favier Dubois, 2009
Saco Viejo	AA75706	*Homo sapiens*-bone	421 ± 43	324–506	Favier Dubois et al., 2009
Saco Viejo	AA81723	*Lama guanicoe*-bone	435 ± 43	324–414	Borella and Buc, 2009
Saco Viejo	AA81722	*Lama guanicoe*-bone	662 ± 44	552–678	Borella and Buc, 2009
SAO – Barrio ALPAT	AA75704	*Homo sapiens*-bone	2330 ± 49	2148–2356	Favier Dubois et al., 2009
SAO – Playón Cementerio	AA75705	*Homo sapiens*-bone	3135 ± 52	3082–3440	Favier Dubois et al., 2009

The probability distributions of ^{14}C dates were obtained using CalPal (2007 version), considering the three micro-regions in isolation as well as grouped together. Radiocarbon dates were calibrated using Calib 6.0 and SHCal04 calibration curve, with 2 standard deviations (McCormac et al., 2004; Stuiver et al., 2005). A Chi square statistical test was applied to the data.

3. Results

In the lower course of the Colorado River, human occupation was detected from ca. 5600 to 200 cal BP (Fig. 2A). The archaeological signal is weak and discontinuous between ca. 5600 and 3000 cal BP, with an absence of radiocarbon dates between ca. 4400 and 3200 cal BP. Although discontinuous, the signal increases between ca. 3200 to 1000 cal BP and, since this period, it is continuous. There is a more intense archaeological signal between 600 and 400 cal BP, decreasing towards ca. 300 cal BP.

In the lower and middle course, as well as in the mouth of Negro River, the archaeological occupation comprises ca. 6500–300 cal BP (Fig. 2B). The Fig. 2B represents a weak and discontinuous archaeological signal between ca. 6500 and 3600 cal BP. For this period, the absence of radiocarbon dates between ca. 5900 and 4900 cal BP, and between ca. 4100 and 3600 cal BP is remarkable. The signal increases significantly since ca. 3500–3000 cal BP, reaching its maximum intensity at ca. 3300 cal BP. From ca. 3000 to 1000 cal BP, the signal decreases, and it is weak and discontinuous. The signal is continuous from ca. 1000 to 400 cal BP and there is a notorious rising, reaching its highest intensity at ca. 500 cal BP. To sum up, the intensity in the archaeological signal of this micro-region is variable, with a rising at ca. 3300 cal BP and at ca. 500 cal BP (Fig. 2B).

In the north coast of San Matías Gulf, human occupation is recorded from ca. 7200 to 300 cal BP. Fig. 2C shows a discontinuous and weak signal between ca. 7200 and 3900 cal BP, with no dates at ca. 6700–6200 cal BP, and at ca. 5000–4000 cal BP, except for one radiocarbon date. Between ca. 3900 and 300 cal BP, the archaeological signal is variable and continuous, with two periods of higher intensity from ca. 3500 to 2000 cal BP, and from 1300 to 300 cal BP. In the latter, the highest intensity is recorded towards ca. 700 cal BP.

All the radiocarbon dates obtained for northeastern Patagonia (Fig. 2D) show a weak archaeological signal, with some discontinuities between ca. 7200 and 3500 cal BP. The signal is continuous and more intense since ca. 3500–300 cal BP. In such period, the highest intensity is recorded at ca. 600–500 cal BP. Later, the signal abruptly decreases.

No statistically significant differences were found when considering the amount of dates among micro-regions (Fig. 2A, B and C), nor when comparing the amounts of dates for coastal and inland areas (Table 4). If radiocarbon values for each micro-region are grouped together by temporal periods, a higher amount of radiocarbon dates for the Late Holocene is observed (Table 4), and there is a statistically significant difference when it is compared to the Middle Holocene. In addition, statistically significant differences are observed between the Middle Holocene and the Initial Late Holocene ($\chi^2 = 16.43$; $P = >0.001$), as well as between the Middle Holocene and the Final Late Holocene ($\chi^2 = 23.73$; $P = >0.001$). However, this difference is not observed between both periods of the Late Holocene ($\chi^2 = 0.741$; $P = 0.389$). Finally, if the amounts of radiocarbon dates for coastal and inland areas for the aforementioned periods are compared, statistically significant differences were recorded for the Middle Holocene and for the Final Late Holocene, but not for the Initial Late Holocene (Table 4).

Table 4
Radiocarbon dates statistical analyses considering the coastal and inland sectors for the three analyzed periods.

Sector	Total	Middle Holocene	Initial Late Holocene	Final Late Holocene
Inland	69	1	29	39
Coastal	67	22	24	21
Total	**136**	**23**	**53**	**60**
		$\chi^2 = 23.83$; $P = >0.001^*$	$\chi^2 = 0.55$; $P = 0.457$	$\chi^2 = 8.74$; $P = 0.003^*$

$^*P \geq 0.05$.

4. Discussion

The previously described patterns of temporal frequency distributions and the intensity and variability of the archaeological signals in each micro-region needs to be explored in depth. As mentioned above, taphonomic and scientific biases, paleoenvironments and population dynamics can influence, either separately or jointly, in temporal frequency distributions of radiocarbon dates.

4.1. History of research, scientific bias and its effects in radiocarbon probability distribution

Each micro-region has a particular history of research. For instance, for northeastern Patagonia the lower course of the Negro River and its mouth has been more intensively explored during the 19th and 20th centuries (see Prates, 2008). Recently, systematic research projects with particular objectives began in the three micro-regions (see Sanguinetti de Bórmida et al., 2000; Eugenio and Aldazabal, 2004; Martínez, 2004; Favier Dubois et al., 2006; Luchsinger, 2006; Prates, 2008). As part of these research programs, radiocarbon dates became available. If the references of Tables 1–3 are considered, with the exception of four radiocarbon dates (Sanguinetti de Bórmida, 1999), the rest were published during 2004–2012. These research projects have intensified investigations in specific sectors of northeastern Patagonia, as part of their particular objectives. Thus, while some research teams emphasized investigations on the coastal area (e.g., Sanguinetti de Bórmida et al., 2000; Eugenio and Aldazabal, 2004; Favier Dubois et al., 2006), some others focused on inland areas of important basins, such as Negro and Colorado rivers (Martínez, 2004, 2008–2009; Prates and Luchsinger, 2005; Luchsinger, 2006; Prates, 2008). In sum, there are differences in previous investigations, in the intensity with certain portions of the landscape are investigated (e.g., coast), and in the objectives of each project developed within the three micro-regions. Nevertheless, the results obtained here indicate that there are no differences in the amount of radiocarbon dates considering the three micro-regions. Thus, scientific biases, at the first glance, cannot be proposed as a factor promoting differences among them. However, in particular micro-regions, such as in the lower course of the Colorado River valley, some sites have been dated intensively. That is the case of the burial structure of Paso Alsina 1 site (10 secondary multiple burials found in a 6 m^2 area; see Fig. 4 in Martínez et al., 2012), where 13 radiocarbon dates (see Table 1) that do not show statistical differences between each other have been obtained. This illustrates the way in which a scientific bias could operate in a micro-regional scale, influenced the temporal frequency distributions of radiocarbon dates.

4.2. Geomorphology and its effects in radiocarbon probability distributions

The probability distribution of the radiocarbon dates observed in each micro-region should be evaluated considering natural processes that operated during the Middle and Late Holocene. In this sense, diverse geomorphologic processes of these arid and semiarid areas (e.g., morphogenesis) can eventually destroy part of the archaeological and/or geological record, affecting and conditioning the temporal frequency distributions (Strickland et al., 2001; Kuzmin and Keates, 2005; Bryson et al., 2006; García, 2010; Peros et al., 2010). In the lower course of Colorado River, Martínez and Martínez (2011) have proposed the existence of a differential archaeological preservation, resolution, and integrity among those inland sites, located in dune fields and aeolian corridors, in contrast to those located on aeolian mantles associated to geomorphologic features of the ancient delta and the coast. In the east portion of the study area (within 0–20 km of the Atlantic coast) archaeological components are recorded in stratified sites, with well-preserved bone material that is generally associated with buried soils from the Late Holocene. In contrast, sites located west of this area (30–100 km from the Atlantic coast) are almost exclusively surface sites and are classified as "palimpsests" recorded in eolian blowouts, where organic material preservation is almost non-existent. Such sites reveal intense geomorphological activity, sudden changes in sedimentation, high erosion rates which are represented by "stone lines". Primary archaeological contexts have been severely modified or destroyed as a consequence of geomorphological processes that favor the destruction of geological features and archaeological sites, as well as the poor preservation of organic material. Archaeological deposits of the Initial Late Holocene (ca. 3000–1000 BP) would be masked under great aeolian mantles and/or lost by intense geomorphological activity (Martínez and Martínez, 2011: 13).

A similar situation is proposed for the middle course of Negro River. Geoarchaeological research (Prates and Luchsinger, 2005; Luchsinger, 2006) shows that the remains of geological features of the Late Pleistocene and Middle Holocene could potentially include stratified sites, but they would be deeply buried by the alluvium of braided rivers and a sequence of aeolian (predominantly loess) deposits. Even though the archaeological record of the Late Holocene is much more visible, both in the stratigraphy and on the surface, portions of it are subject to dramatic natural formation processes, such as river channel avulsion (Luchsinger, 2006: 118). Both previously described cases correspond to inland areas of the micro-regions of Negro River and the lower course of the Colorado River, and could partially explain the radiocarbon plots presented in Fig. 2A and B. Generally speaking, sites located inland have lower archaeological visibility, and when they are actually found they have a differential preservation of organic material, which in turn reduces the possibilities to obtain radiocarbon chronologies.

In the case of the north coast of the San Matías Gulf, in spite of the coastal transformation that this landscape underwent (see Section 1.2), sites belonging to the Middle and Late Holocene are found along the current Atlantic coast (Favier Dubois and Kokot, 2011). The largest concentration of the archaeological record is located on dunes developed on the Holocene terrace, corresponding to Late Holocene human occupations. This material has been preserved in sandy mantles and in very good condition. Occupations dated to the Middle Holocene and located on ancient Pleistocene spits, are characterized by poor preservation of the archaeological record mainly composed by the most resistant elements (e.g., otholits, stone fishnet weights; Favier Dubois and Kokot, 2011: 108).

Coastal areas of the micro-regions of Negro River and of the north coast of the San Matías Gulf have geological features such as cliffs, and old beaches with greater archaeological visibility (see Eugenio and Aldazabal, 2004; Favier Dubois and Kokot, 2011). This situation allows for the detection of more archaeological contexts that can be dated. In contrast, in the lower course of the Colorado River, related to the ancient delta, the coast is characterized by a gentle relief, low slopes, and no cliffs are present (Martínez and Martínez, 2011), all of which do not allow for the detection of archaeological sites and/or reduces their visibility and chronology. Furthermore, coastal settlements from the northern of the San Matías Gulf and the mouth of the Negro River present conspicuous features such as shell-middens. These contexts have a very good preservation of faunal and anthracological remains, as well as high resolution and integrity (Eugenio and Aldazabal, 2004; Favier Dubois et al., 2009: 991). Consequently, there is a higher possibility to recover material in order to be dated, and also to get older chronologies (Fig. 2C). This is consistent with the statistical results that were obtained since there is a higher amount of Middle Holocene dates belonging to the coast than to inland sectors (see Figs. 3 and 4 and Table 4). During the following period, the Initial Late Holocene, these differences are not statistically observed with a similar amount of dates for coastal and inland areas. This contrasting situation between inland and coastal sites considering the

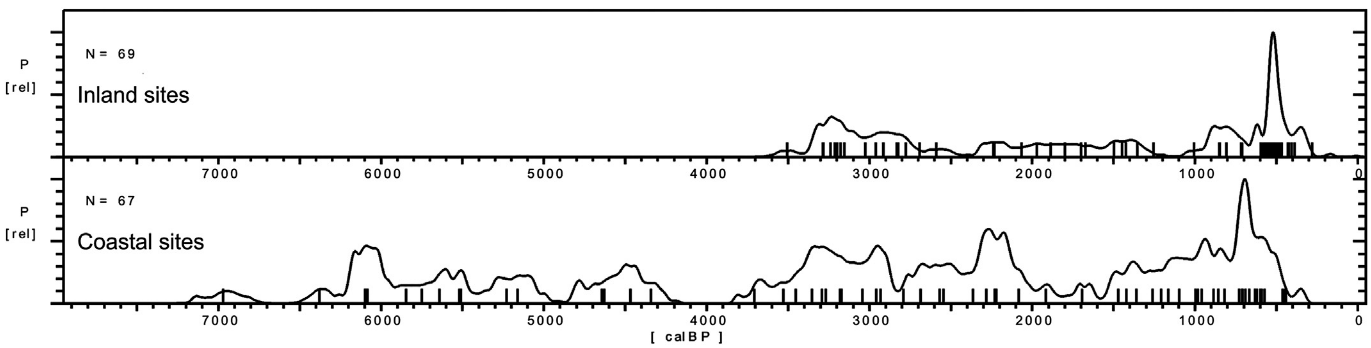

Fig. 3. Comparison of temporal frequency distribution between coastal and inland sectors.

two contiguous periods mentioned above, would indicate that perhaps early sites located inland were either destroyed or less visible since they are buried. Even though there is parity in the number of dates for coastal and inland areas, Fig. 3 clearly shows that sites no older than Late Holocene are recorded in the latter. Regarding the Final Late Holocene, there is a higher amount of radiocarbon dates corresponding to inland areas (Table 4). In this case, the statistical differences observed between coastal and inland areas could be explained due to the intensity that some inland archaeological contexts (e.g., Paso Alsina 1 site) have been dated (See Section 4.1).

To sum up, the chronological trends and the observed differences among micro-regions (Fig. 2A, B and C) might in part be related to different geomorphological processes. For the reasons mentioned above, it is proposed that taphonomic bias (sensu Surovell and Brantingham, 2007: 2) had an important role in temporal frequency distributions and the intensity of archaeological signal among micro-regions and northeastern Patagonia.

4.3. Palaoenvironment, population dynamics and their effects on radiocarbon probability distributions

Although paleoclimatic information is still scarce for northeastern Patagonia (Schäbitz, 1994, 2003; Martínez and Martínez, 2011; Marcos et al., 2012) some tendencies can be recognized. In general terms, it can be suggested that arid climatic conditions (ca. 7500–4000/3000 BP), are followed by arid-semiarid ones (ca. 3000–1000 BP), with a period of climatic amelioration followed by a return to arid conditions (ca. 400 BP). The older evidence of human occupation in northeastern Patagonia is at ca. 7200 cal BP and radiocarbon date distributions reveal a weak archaeological signal, with some discontinuities until ca. 3500 cal BP (Fig. 2D). Although the possibility of lower population numbers for this arid period cannot be neglected, the geomorphological processes and taphonomic biases preclude the comprehension of climate's effect on human population. Later, during Late Holocene, under arid-semiarid conditions, the archaeological signal is continuous and more intense, since ca. 3500 cal BP. Beyond the taphonomic bias that also operated during this period, an increment in the archaeological signal is recorded, suggesting larger human populations. This situation is particularly noticeably for ca. 600–400 cal BP.

It is proposed that during the Final Late Holocene, there was an intense and constant use of some sectors of northeastern Patagonia, such as lower basins of important rivers and the Atlantic coast. Based on comparisons with paleoclimatic data from other sectors of Patagonia (e.g., Cardiel Lake), Barrientos and Gordón (2004: 54) and Gordón (2011: 72) proposed that the Medieval Climatic Anomaly (Stine, 1994) would have generated environmental conditions that induced demographic packing at the sectors of landscapes such as the lower valleys of the Colorado and Negro rivers and the nearby Atlantic coast. Considering the severe climatic conditions of this event, the attraction of places with surface water (e.g., fluvial valleys) and with important productivity (e.g., marine coast) would have resulted in a regional and local increment of demography and spatial circumscription (Barrientos and Perez, 2004: 189; Favier Dubois et al., 2009: 994; Gordón, 2011: 6).

In this regard, as observed in Fig. 2D, the intensity of the archaeological signal during the period proposed for the MCA is similar to previous moments, especially the Middle Holocene to Late Holocene transition (ca. 3000 cal BP). Taking into account the periods ca. 3400–2800 cal BP and ca. 1000–600 cal BP, the number of radiocarbon dates for each is the same ($n = 21$) and the intensity of the archaeological signal is similar. In others words, the increment in the archaeological signal was not exclusively recorded for the Final Late Holocene. Until more detailed paleoclimatic information for northeastern Patagonia is available, therefore, there is no basis to link specific climatic events with changes in demography. For this reason, it is difficult to extrapolate a static scenario of specific climatic conditions, chronology and its effects on human populations, as in the case of the MCA (see Barrientos and Gordón, 2004; Gordón, 2011), when this was recorded in other latitudes. For instance, in Southern Patagonia, paleoclimatic reconstructions derived from multi-proxy studies in lake environments (e.g., Cardiel Lake and Potrok Aike lagoon) clearly show evidence for the existence of the MCA (Stine, 1994; Haberzettl et al., 2005; see; Morales et al., 2009) and its impact on human populations (Borrero and Franco, 2000; Goñi et al., 2000–2002). However, its chronological expression also varies across this region (Soon et al., 2003; Agosta et al., 2005; Barberena, 2008; Morales et al., 2009). In the same way, paleoclimatic information generated about the LIA is very uneven in different regions. While in Southern Patagonia there are several proposals based on a significant quantity of proxy data (Favier Dubois, 2003; Haberzettl et al., 2005; Koch and Kilian, 2005; Barberena, 2008; Kastner et al., 2010), in the Pampean region and in northeastern Patagonia the information is scarce and derived from very few proxies (Lirio et al., 2007; Tonni et al., 2008; Piovano et al., 2009). Furthermore, unlike the discussion generated from the possible effects that the MCA may have had on human populations (see above), there are no archaeological and behavioral models linking the effects of the LIA with demography and use of space by hunter–gatherer groups in northeastern Patagonia.

It is proposed that arid-semiarid environments located near the ocean have some advantages compared to continental environments in semiarid regions, related to higher and sustained productivity, temperate climatic conditions and higher water tables, among others (Bailey and Milner, 2002; Borrero and Barberena, 2006; Favier Dubois et al., 2009). However, even though the environmental productivity is higher in places such as deltas and estuaries (Acha and Mianzan, 2006; Pasquaud et al., 2008), the productivity in inland river environments should not be underestimated. Such places constitute structural components called corridors (sensu Forman and Godron, 1986: 736), that is, sectors that border water courses. Corridors can be isolated or connected to other resource patches, in the latter case with a higher bioproductivity. They also promote species dynamics, including humans, thus constituting a more efficient migration system, with advantages for human mobility and settlement (Forman and Godron, 1986: 737). Luchsinger (2006) and Prates (2008) present geoarchaeological and archaeological cases that show the importance of these environments in the middle course of the Negro River. Whereas in high plateaus next to valleys the archaeological record is scarce, the human occupation is intense along paleo-channels and flood channel shores. Such sites, with chronologies not older than ca. 2500 BP, are located next to inactive water bodies, and related to temporary lagoons. They were defined as base camps and the variability of exploited resources is noticeable: vegetables, artiodactyls, armadillos, rodents, birds, turtles, fish, freshwater gastropods, etc. (Prates, 2008). This suggests that inland areas, especially fluvial valleys (considered as corridors) also offered an important resource diversity and productivity that would have encouraged intensive human occupation. Consequently, the less intense archaeological signal of inland areas could be the result of a site-detecting problem (e.g., site destruction, sites located under important aeolian mantles, etc.; Prates and Luchsinger, 2005; Luchsinger, 2006; Prates, 2008; Martínez and Martínez, 2011). Thus, in this arid-semiarid region, both the coast and inland fluvial valleys have a high biodiversity and bioproductivity that potentially encourage the settlement of hunter–gatherer populations. The archaeological signal shows an almost continuous occupation of these sectors of landscape through Middle and Late Holocene (Fig. 2D).

4.4. Hunter–gatherers social reorganization and its effects on radiocarbon probability distributions

The distribution of a positive curvilinear frequency of radiocarbon values through time is commonly interpreted in archaeology as changes in human demography, based on the premise that a population increase generates a rising in the archaeological signal (see Rick, 1987; Gamble et al., 2005; Shennan and Edinborough, 2007; Surovell and Brantingham, 2007; Peros et al., 2010). In the temporal frequency curves for the three micro-regions (Fig. 2A, B and C) and for northeastern Patagonia (Fig. 2D), an increase in the archaeological signal is observed for the Final Late Holocene. The same trend is recorded by an increase in the amount of sites for recent moments (Fig. 4). Summed probability distributions of radiocarbon dates presented in this paper shows an increase in the archaeological signal for the last 1000 cal BP, especially between ca. 600 and 400 cal BP (Fig. 2D). For northeastern Patagonia and neighboring areas, it has been proposed that a demographic increase accompanies deeper changes in the organization of hunter–gatherer societies, such as spatial constraints, territoriality, diversification on consumption of fauna, processes of intensification in the exploitation of food and mineral resources, longer and more stable settlements, reduction of residential mobility, changes in mortuary behavior (secondary burials), existence of formal burial areas, among others (Barrientos and Gordón, 2004; Barrientos and Perez, 2004; Gómez Otero, 2006; Martínez, 2008–2009; Politis, 2008; Prates, 2008; Favier Dubois et al., 2009; Gordón, 2011; Martínez et al., 2012; Stoessel, 2012a). Such socio-demographic changes are consistent with an increase in the archaeological signal at a micro-regional level, and in northeastern Patagonia as a whole. Putting aside the biases that were discussed here, and that undoubtedly impact on temporal frequency distributions, as well as the fact that there is a higher possibility for finding more recent settlements (Holdaway et al., 2005; Surovell et al., 2009), it might

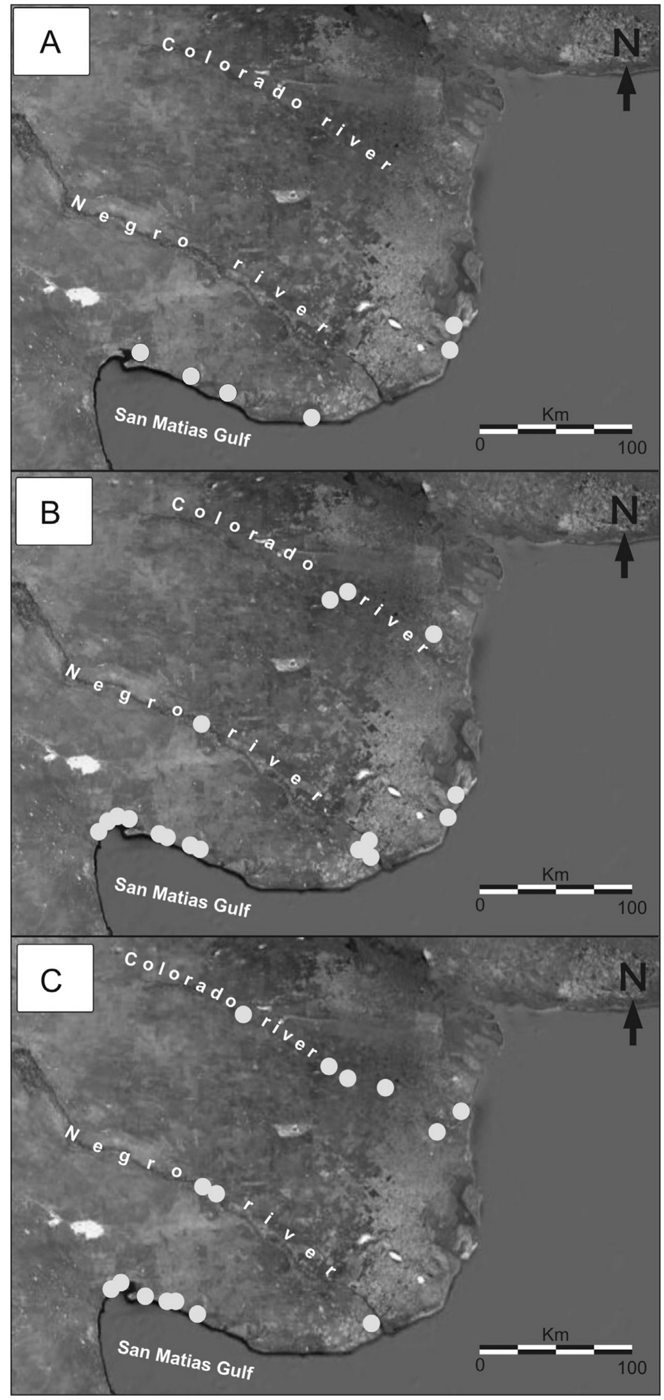

Fig. 4. Presence and distribution of archaeological sites in Northeastern Patagonia for the three analyzed periods. A) Middle Holocene, B) Initial Late Holocene, and C) Final Late Holocene.

be proposed for our case study that there is a correspondence between the higher intensity of the archaeological signal and the higher population density proposed for the last 1000 BP (Final Late Holocene). For this period, beside the probability distribution of radiocarbon dates as a quantitative technique to explore the intensity of space use and population dynamics, there is also qualitative data that should be used in conjunction. Thus, qualitative changes in the organization of lithic technology (e.g., specialization in tool production; Armentano, 2012) and in the ways in which the faunal resources are exploited and consumed (e.g., intensification and diversification processes; Favier Dubois et al., 2009; Prates, 2008; Scartascini, 2012; Stoessel, 2012a,b) deserve to be evaluated from a more integral perspective. Furthermore, evidence such as the emergence of exclusive burial areas composed of dozens of individuals (e.g., Paso Alsina 1 and Bajo de la Quinta-Cima de los Huesos sites; Favier Dubois et al., 2009; Martínez et al., 2012), the first appearance of secondary multiple burials, and base camps reoccupied through time, and used for both domestic and burial purposes (Prates et al., 2010a; Martínez et al., 2012) provides other qualitative data that complement quantitative tendencies generated by summed probability distributions of radiocarbon dates. To sum up, besides the biases that probably affected the temporal frequency distributions of radiocarbon dates for the Final Late Holocene, it is proposed that the intensity of archaeological signal responds to a higher demography.

5. Final considerations

Considering the data as a whole, it is observed that in northeastern Patagonia, the earliest evidence of human occupation corresponds to ca. 7200 cal BP, and followed by a continuous hunter–gatherer occupation since ca. 3800–300 cal BP. It is proposed that the absence of earlier occupations in northeastern Patagonia is a consequence of geomorphological processes that produced destruction, poor preservation and low visibility of archaeological sites (Prates and Luchsinger, 2005; Luchsinger, 2006; Martínez and Martínez, 2011). This is the most probable explanation, since there are well established early settlements in neighboring areas, such as Pampa and North Patagonia (see Steele and Politis, 2009; Miotti et al., 2010, and references therein).

The differences of the archaeological signals in each micro-region and in northeastern Patagonia are partially the result of taphonomic bias. Nevertheless, despite the possible presence of biases, other factors placed an important role. In this sense, the increment in the archaeological signal during the Final Late Holocene (basically for ca. 600–400 BP) could indicate a greater demography and intensity of human settlement in northeastern Patagonia. The rise of demography occurred simultaneously within a cultural context of hunter–gatherers undergoing important organizational changes, where significant processes of social interaction networks and complementarity between groups took place (Berón, 2007; Berón et al., 2007; Martínez, 2008–2009; Gordón, 2011; Martínez et al., 2012), and it is not necessarily related to paleoecological changes (e.g., MCA).

The present case study shows some similarities with others from different parts of the world such as Australia and the United States. First, it illustrates the differences that can be recorded in temporal frequency curves according to the selected spatial scales. In this sense, the obtained results can potentially show an important variation within small geographical areas (Holdaway et al., 2005: 46; Fanning et al., 2009: 142), such as the micro-regions selected in this paper. Discontinuities in temporal frequency curves and their relationship with the behavioral responses to climatic changes strongly depend on how solid the local paleoclimatic reconstructions are (Fanning et al., 2009: 133). The increase in the amount of sites after the Middle Holocene is partly due to the better preservation of these sites in contrast to the ones belonging to earlier periods (Meltzer, 1999: 408; Holdaway et al., 2005: 47; Holdaway et al., 2008: 405; Smith and Ross, 2008: 382, 385; Fanning et al., 2009: 143; Louderback et al., 2010: 372).

It has been proposed that the increase in artifact discard rates and in radiocarbon frequencies does not necessarily indicate intensive settlements and substantial population growth (Holdaway et al., 2005: 47; Hiscock, 2008: 221). However, as proposed in this paper, qualitative evidence concerning the reorganization of hunter–gatherer societies (e.g.; changes in burial practices, subsistence, technology) in order to complement the results obtained by temporal frequency distributions is essential to improve the evaluation of the increase in population size and prehistoric demography.

Acknowledgments

We are very grateful to Ramiro Barberena, Juan Belardi, Adolfo Gil, Luciano Prates and Heidi Luchsinger whom provided very important insights and suggestions on this paper. We also thank two anonymous reviewers that improved the paper. The authors are grateful to Benjamín Alberti for his assistance with language correction. Research was funded by ANCyPT (PICT-264). Thanks to INCUAPA-CONICET (Department of Archaeology, Facultad de Ciencias Sociales, Universidad Nacional del Centro de la Provincia de Buenos Aires). We are responsible for the contents of this paper.

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