Quaternary Science Reviews 112 (2015) 181–196

Contents lists available at ScienceDirect

Quaternary Science Reviews

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

Prehistoric fires and the shaping of colonial transported landscapes in southern California: A paleoenvironmental study at Dune Pond, Santa Barbara County

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ARTICLE INFO

Article history:
Received 21 July 2014
Received in revised form
19 November 2014
Accepted 19 January 2015
Available online 20 February 2015

Keywords:
Colonial transported landscapes
Fire history
Pollen
Non-pollen palynomorphs
Spheroidal Carbonaceous Particles
California

ABSTRACT

Using a novel combination of paleoecologic proxies including pollen, non-pollen palynomorphs (NPPs), macroscopic charcoal, and Spheroidal Carbonaceous Particles (SCPs), 5000 years of landscape change, fire history and land-use have been reconstructed from Dune Pond, Santa Barbara County, California. The pond was sensitive to Holocene regional climatic variability, showing different phases of lower (4600–3700 cal yr BP, 2100–700 cal yr BP, historical period) and higher (3700–2100 cal yr BP, 700–150 cal yr BP) local moisture availability. During this period the landscape was dominated by a coastal mosaic vegetation including dune mats, coastal scrub and salt marshes on the dunes and backdunes, with chaparral and oak woodland growing in the valley plains and foothills. Fire was intimately linked with such dominating mosaic vegetation, and the combination of wet conditions and the presence of nearby human settlement were a trigger favoring coastal fires for at least two periods: from 3100 to 1500 cal yr BP and from 650 cal yr BP until the 18th century. In both cases fire was an important tool to keep an open coastal landscape attractive to hunting wildlife. Finally, matching this varied range of high-resolution paleoecological proxies with historical records we could characterize the development of colonial transported landscapes following the Euro-American settlement of Santa Barbara. The introduction of livestock grazing by Spanish colonists favored erosive processes and the introduction of fecal-borne parasites in freshwater bodies, negatively impacted salt and brackish coastal marshes, and promoted the invasion of alien grasses and ruderals. This agro-pastoral landscape was consolidated during the American period, with a greater role for cultivation, the development of industrial activities and increased population. Despite negative environmental consequences such as the loss of native habitats, exotic land-uses and plants introduced during the historical period significantly contributed to the configuration of a cultural landscape which forms part of the cultural heritage of California.

1. Introduction

Our knowledge about the long-term vegetation and fire history of coastal regions of southern California has been limited by the restricted availability of preserved wetlands suitable for paleoecological studies in this dry and highly developed area of the western US. Such widely dispersed studies such as Soledad Pond and Abalone Rocks Marsh on Santa Rosa Island (Cole and Liu, 1994; Anderson et al., 2010), San Joaquin Marsh (Davis, 1992), Los Peñasquitos lagoon (Cole and Wahl, 2000), Mod Pond (Anderson et al., 2015) and the Santa Barbara Basin marine record (Heusser, 1978), and most recently Zaca Lake (Dingemans et al., 2014) have provided an introduction to late Holocene paleoenvironments of the region. Fire history studies have been even more limited. In this case, only two high-resolution fire reconstructions are available for the mainland southern California coast at the Santa Barbara Basin (Mensing et al., 1999) and at Los Padres National Forest (Lombardo et al., 2009), spanning the last 600 and 400 years, respectively.

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http://dx.doi.org/10.1016/j.quascirev.2015.01.017
0277-3791/

Here we present a multi-proxy paleoecological study of an interdunal swale pond located just a few km west of Santa Barbara, California, spanning the last 5000 years. The unusual length of the Dune Pond record offers new insights into the presently poorly known vegetation and fire history of southwestern coastal areas of California. Dune Pond is located within the Coal Oil Point Reserve (COPR). Established in 1970, this reserve attempts to protect one of the best remaining examples of a coastal-strand environment in southern California. Together with the analysis of pollen, our study includes non-pollen palynomorphs (NPPs). These are microorganisms of diverse origin, such as fungal and algal spores or zoological remains, which provide additional and independent on-site paleoenvironmental and land-use information to pollen analysis (van Geel, 2001). Despite being increasingly important indicators in paleoenvironmental analyses, their systematic use is still scarce, especially in North America.

The southern California coast has long been occupied by prehistoric peoples. It includes the earliest human remains thus far found on the Pacific coast, dating back to ~13,000 cal yr BP (Erlandson et al., 2011), and over the last 20 years numerous additional archaeological sites have been recorded in the Santa Barbara basin area (Glassow et al., 2007). However, little is known regarding the impact of prehistoric forager communities on their immediate environment. Our knowledge increases considerably during the late 18th century historic period, as European explorers produced written ethnographic accounts about the way of life of Native American communities and their relationship to their environment. Ethnohistoric accounts attest to the frequent and intentional use of fire by Chumash societies in the Santa Barbara Basin area in one of the best examples of intentional burning by prehistoric hunter–gatherers (Timbrook et al., 1982). Additional examples exist in the paleoecological record relating prehistoric fires to anthropogenic triggers in the north-central California coast (Anderson et al., 2013) as well as the northern Channel Islands (Anderson et al., 2010). However, little is known about the possible use of fire by prehistoric communities in the mainland coast of southern California because of the lack of high-resolution and long-term charcoal analysis. Our study includes a high-resolution charcoal analysis, which contributes significantly to understanding the role of natural and/or anthropogenic fires in the Holocene shaping of Mediterranean coastal ecosystems.

One of the most significant observations of changing cultural and environmental history of coastal Californian landscapes began with Spanish colonization in the late 18th century. Societies place a high value on their local ecosystems for their economic, symbolic and cultural properties. When people move to a new territory, they often take basic elements of their landscapes with them, creating in this way the 'so called' transported landscapes. These imply the introduction of new land-uses, plants and land organization systems, which colonists use to transform local landscapes to their own socio-economic and cultural patterns (Anderson, 1952; Kirch, 1982; Palet and Orengo, 2011). The colonization of the Alta California involved the development of agro-pastoral land-use systems which were new to this part of the New World, leading to the configuration of a new cultural landscape in coastal California (Anderson et al., 2013). It is estimated that ~20% of the current California flora is composed of nonnative species introduced during the last 150 years (Bossard and Randall, 2007). Nonnative plants have forever changed the landscape of California, reflected in current management policies of natural parks and reserves, which seek to control the expansion of many introduced taxa and restore indigenous vegetation (Rick et al., 2014). However, currently important introduced plants and land-uses are also part of the cultural landscape heritage of modern California, which includes, among other things, exotic crops such as grape vineyards and olive orchards. Despite its significance, understanding the role of colonial transported landscapes in shaping modern cultural landscapes has been poorly addressed so far (Sluyter, 2002). The paleoecological study of Dune Pond contributes to a characterization of this process for southern California. This is essential in order to develop landscape management strategies that take into account both the value of restoring native landscapes and the cultural dimension of the colonial landscapes which developed during the historical period in this region.

The study of colonial landscapes from a paleoecological perspective is hampered by the limitations of constructing reliable age–depth models for the historical period. This includes the limited accuracy of radiocarbon dating for recent periods, and problems related with radiometric dating such as downwash and displacement effects through the sediment (Oldfield et al., 1995). Here we present an innovative methodology which includes the coupling of radiometric dating ($^{239+240}$Pu), stratigraphic changes in pollen and NPPs, historical accounts and a novel dating technique for the first time employed in western North America: Spheroidal Carbonaceous Particles (SCP). SCPs result from the industrial combustion of fossil fuels and are unambiguous indicators of industrial processes. Due to a characteristic morphology they can be identified and compared with historic records of fossil-fuel combustion to generate reliable chronologies for the industrial period (Rose, 2001). Dune Pond is perfectly positioned for this analysis as it is not only located in one of the historically most productive areas of oil exploitation in California (Schmitt et al., 2003), but is itself situated adjacent to the former Elwood oil field (Fig. 1). The historical significance of this region as an oil production center is underlined by the fact that the Elwood oil field became a target of the 1942 Japanese shelling of the US during WWII (Baker, 2003).

The main objectives of this paper are (1) to provide paleoecological data regarding vegetation history and environmental change in Southern California for the last 5000 years; (2) to assess the role of fires in the Holocene development of California coastal vegetation habitats and evaluate those natural and anthropogenic triggers behind prehistoric fires; and (3) to characterize the development of colonial transported landscapes in Southern California coastal areas, including distinct landscape transformations related to the Spanish, Mexican and American settlement of Santa Barbara.

2. Archaeo-historical context

The Santa Barbara coastal area holds one of the most ancient and intense prehistoric occupations in California. During the Middle Holocene, between 4500 and 3500 cal yr BC, an increase in archaeological sites is reported, with the occupation of sites like SBA-78, 83, 84 and 53 (Fig. 1). These were frequented by mobile forager societies who relied on the combined exploitation of marine and land resources (Glassow et al., 2007). Very few archaeological sites are identified between ~3000 and ~2000 cal yr BC in the Santa Barbara Channel area, but increased settlement is documented after this, and increasingly so since ~800 cal yr BC in areas neighboring Dune Pond with the occupation of SBA-81 and 71 [Fig. 1, Table 1]. This increase in the number of archaeological sites included significant socioeconomic and cultural changes, such as increased sedentism, larger sites and burials, village layout, ceremonial practices or a resource diversification with a major role for fishing, and sea and land mammal hunting than before (Erlandson and Rick, 2002). Radiocarbon dates support the occupation of many sites during the late Holocene until the contact period or shortly before during the 15th–16th centuries (Table 1, Fig. 1). At the time of Spanish contact the mainland Santa Barbara coast was occupied by Chumash populations. These were hunter–gatherers with a