Quaternary Research 85 (2016) 380–390

Contents lists available at ScienceDirect

Quaternary Research

journal homepage: http://www.journals.elsevier.com/quaternary-research

Postglacial vegetation history of Orcas Island, northwestern Washington

Estella B. Leopold [a], Peter W. Dunwiddie [a, *], Cathy Whitlock [b], Rudy Nickmann [c], William A. Watts [d, 1]

[a] Biology Department, University of Washington, Seattle, WA 98195, USA
[b] Department of Earth Sciences and Montana Institute on Ecosystems, Montana State University, Bozeman, MT 59715, USA
[c] 15 Somers Avenue, Bergenfield, NJ 07621, USA
[d] School of Botany, Trinity College, Dublin, USA

ARTICLE INFO

Article history:
Received 26 March 2015
Available online 13 April 2016

Keywords:
Island biogeography
Postglacial pollen
Northern Puget Lowland
Bison antiquus habitat
San Juan Islands

ABSTRACT

The revegetation of islands following retreat of Pleistocene glaciers is of great biogeographical interest. The San Juan Islands, Washington, feature regionally distinctive xerophytic plant communities, yet their vegetation history, as it relates to past climate and sea level, is poorly known. We describe a 13,700-year-old pollen record from Killebrew Lake Fen and compare the vegetation reconstruction with others from the region. The data suggest that the narrow channels surrounding Orcas Island were not a barrier to early postglacial immigration of plants. Between 13,700 and 12,000 cal yr BP, *Pinus*, *Tsuga*, *Picea*, *Alnus viridis*, and possibly *Juniperus maritima* were present in a mosaic that supported *Bison antiquus* and *Megalonyx*. The rise of *Alnus rubra-type* pollen and *Pteridium* spores at ca. 12,000 cal yr BP suggests a warming trend and probably more fires. Temperate conifer taxa, including Cupressaceae, *Pseudotsuga*, *Tsuga heterophylla*, and *Abies*, increased after 11,000 cal yr BP and especially in the last 7000 cal yr BP. After 6000 cal yr BP, *Pseudotsuga* and Cupressaceae dominated the vegetation. The last 1500 yr were the wettest period of the record. Due to its rain shadow location, Orcas Island experienced drier conditions than on the mainland during most of the postglacial period.

Introduction

How biota of island ecosystems are assembled has long fascinated biologists and biogeographers. In the case of continental islands, the vegetation history is influenced by Quaternary glaciation as well as postglacial climate, and by the timing and rates of eustatic, isostatic, and tectonic sea-level rise. Changes in climate and sea level affect the size and topography of islands and their degree of isolation from source regions, all of which adds complexity to the vegetation history.

The San Juan (U.S.) and Gulf Islands (Canada) of the Pacific Northwest are an archipelago that includes hundreds of islands, and thus provide an unusual opportunity to examine biogeographic and paleoecological questions related to the assembly and sensitivity of island biota in the face of multiple environmental agents. The archipelago lies in the Salish Sea, which includes northern Puget Sound and the Strait of Georgia, and is surrounded by the Olympic Peninsula of western Washington, the Puget Lowland and Cascade Range of the Washington mainland, and Vancouver Island and the coastal ranges of southern British Columbia (Fig. 1). The islands are generally in close proximity to one another and separated from the mainland by deep, narrow channels. The present study concerns Killebrew Lake Fen, which lies on the southern part of Orcas Island (Figs. 1 and 2). During the late Pleistocene Vashon advance of the Cordilleran Ice Sheet, the islands were covered by over 1220 m of ice, with no possibility of biotic refugia (Alley and Chatwin, 1979; Thorson, 1980); thus, the present flora consists entirely of postglacial immigrants.

Postglacial emergence of the San Juan Islands was determined by the interaction of retreating Vashon ice, isostatic and eustatic sea-level fluctuations, deposition and erosion of outwash sediments, and shoreline erosion. Some of these parameters varied greatly over relatively short distances, and in many cases the timing of events is not well constrained. There is general agreement that

* Corresponding author.
E-mail address: pdunwidd@u.washington.edu (P.W. Dunwiddie).
[1] Deceased.

http://dx.doi.org/10.1016/j.yqres.2016.02.004
0033-5894/

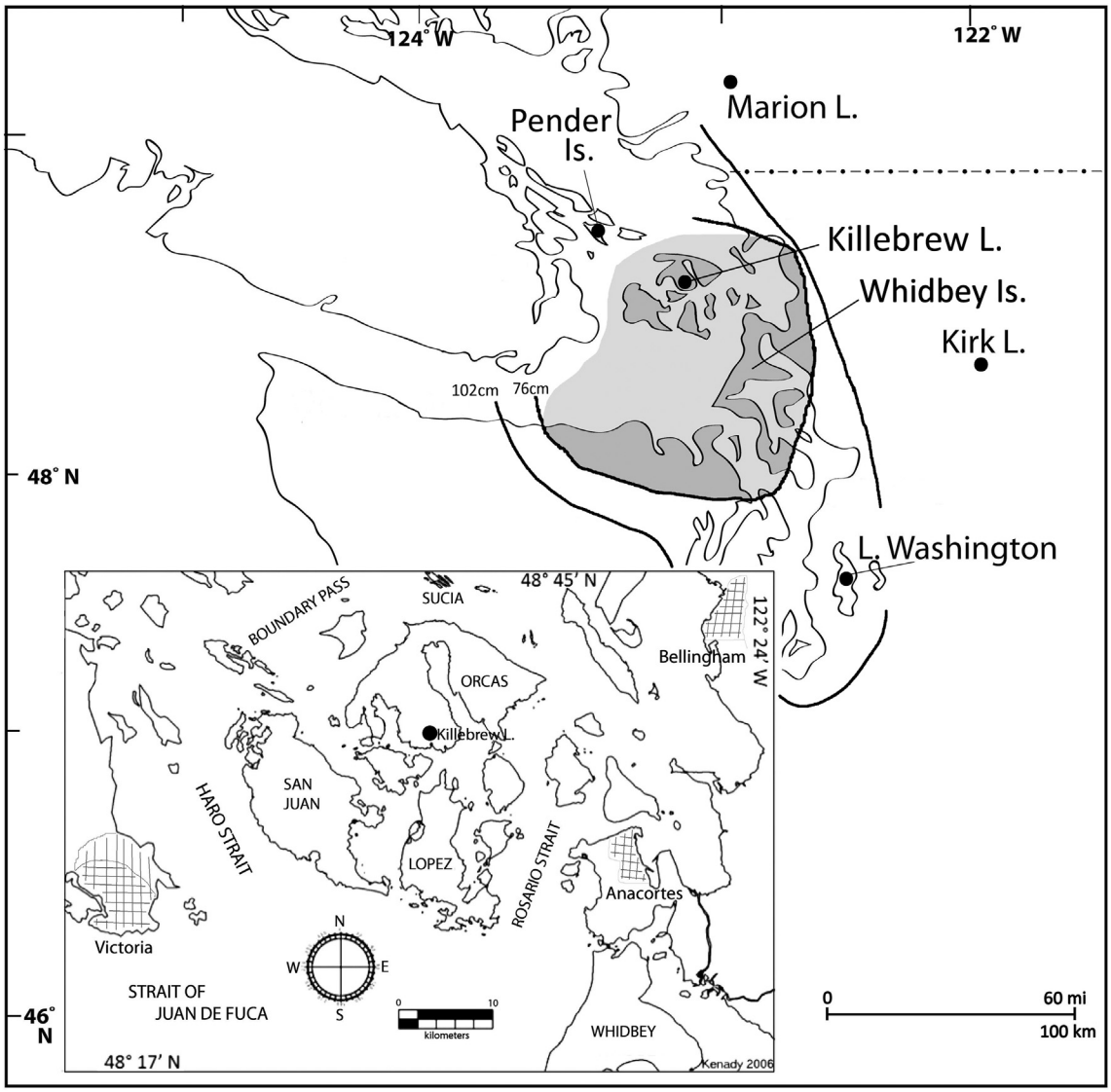

Figure 1. Location of Killebrew Lake Fen on Orcas Island and other fossil pollen sites mentioned in the text. The black solid lines outline the rain shadow cast by the Olympic Range and the mountains of Vancouver Island. Average annual precipitation within the shaded area is <76 cm. The outer line delineates annual precipitation <102 cm (Source: http://www.mgsengr.com/precipfrqfiles/wa_MAP.png).

the islands were free of ice by or during the period from ~14,500 to 13,600 cal yr BP (Mosher and Hewitt, 2004), after the rapid retreat of the Vashon and Juan de Fuca lobes. During the early postglacial period, southeastern Vancouver Island was partly submerged as a result of isostatic depression, when relative sea level lay 75+ m higher than present (James et al., 2009); Wilson et al. (2009) estimated a similar sea level high stand (70 m asl) on Orcas Island at that time. Relative sea level quickly dropped with isostatic rebound, and reached a low stand of approximately −30 m asl by ca. 11,200 cal yr BP (James et al., 2009), but others have argued for levels as low as −55 to −60 m at ca. 11,000 cal yr BP (Mosher and Hewitt, 2004). By ca. 6000 cal yr BP, sea level rose to its present elevation. James et al. (2009) and Wilson et al. (2009) have presented hypothetical reconstructions depicting how the configuration of islands and channels in this area may have differed in size and proximity with changes in relative sea level following retreat of the Cordilleran ice. During the lowest stand, channels separating the San Juan Islands from mainland Washington and from Vancouver Island were several kilometers wide, and Orcas, Shaw, Lopez, and Blakely islands were connected to form a single, large island that was separated by narrow channels from San Juan Island.

The postglacial vegetation history of coastal areas in the Pacific Northwest is understood from pollen diagrams from southern Vancouver Island (Allen, 1995; Pellatt et al., 2001; Brown and Hebda, 2002, 2003), western British Columbia (Mathewes, 1973), Roe Lake in the Gulf Islands (Lucas and Lacourse, 2013), the Olympic Peninsula (Heusser, 1974; Petersen et al., 1983; McLachlan and Brubaker, 1995; Heusser et al., 1999; Gavin et al., 2013; Gavin and Brubaker, 2015) and northwestern Washington (Hansen and Easterbrook, 1974; Cwynar, 1987). However, little is known regarding the postglacial vegetation history of the San Juan Islands themselves. Hansen (1943) described a postglacial pollen sequence from Killebrew Lake Fen, but only some conifer taxa were counted (e.g., no Cupressaceae), total pollen counts were low, and the analysis was carried out prior to the advent of radiocarbon dating and before modern pollen taxonomy. Sugimura et al. (2008)