CHANGES IN OAK DISTRIBUTION AND DENSITY BY DECADE ON SANTA CATALINA ISLAND, 1943 TO 2005

Denise A. Knapp
University of California, Santa Barbara
Ecology, Evolution, and Marine Biology Department
Santa Barbara, CA 93106-9610
dknapp@lifesci.ucsb.edu

ABSTRACT: Historical aerial photographs were examined for changes in canopy cover of *Quercus pacifica* to test the hypothesis that this endemic oak tree has decreased in extent on Catalina Island within the last 60+ years. Photographs from each decade starting in the 1940’s were systematically searched for the entire area west of the island’s isthmus and changes were mapped and quantified. Since the 1940’s, 159 hectares (31%) of oak habitat have been lost in this area, and no recruitment into the canopy layer was noted to offset this loss. The majority of the loss was due to a gradual dieback, with its peak initiation in the 1970’s; a small portion was also due to human clearing. Browsing and acorn predation by introduced animals is likely an important factor in the lack of regeneration of these declining woodlands. If this decline was consistent with the rest of the island, oaks would have covered 33% of Catalina in the 1940’s, a loss of 1,988 ha. over the past 60+ years. This large-scale dieback could produce a negative feedback for future regeneration by reducing the availability of pollen and hindering reproduction.

KEYWORDS: Catalina Island, dieback, oaks, *Quercus pacifica*

INTRODUCTION

Populations of multiple oak tree species in California, both on the mainland and Channel Islands, have been both shown (Bolsinger 1988, Brumbaugh 1980, Johnson 1980, Brown & Davis 1991, Grossinger et al. 2007) and surmised (Clark et al. 1990, Hauselt 2003) to have decreased in area over the past two centuries, while a lack of regeneration in at least three species means that what remains of those species is not being replaced (Mensing 1992, Swiecki et al. 1997a, Standiford 2002). Historic livestock ranching, mining, recreation, fuelwood collection, and introduced animals have likely decreased the cover of oak trees on Santa Catalina Island (hereafter Catalina) in a similar fashion. Richard Minnich (1980), based on an analysis of re-located ground photographs of the Avalon area, speculated that Catalina supported widespread woody vegetation before the introduction of domestic animals.

*Quercus pacifica* (Island scrub oak) is the predominant oak species on Catalina, and is endemic to the Channel Islands. A large-scale dieback of this tree has been noted in the last decade, while little regeneration has been noted. The purpose of the current study was to test the hypothesis that *Q. pacifica* cover has decreased within the last 60+ years on Catalina Island.

METHODS

Aerial photographs were obtained and spatially referenced (orthorectified) for each decade starting with the earliest photographs available. Years for which photographs were obtained include 1943, 1952, 1968, 1974, 1980, 1994, and 2005. The entire area west of the Isthmus (the “west end”) was evaluated for oak cover changes by systematically investigating photographs in each 1,000m by 1,000 m cell of a Universal Transverse Mercator (UTM) grid within ArcView 3.2 (ESRI, Redlands, CA), a Geographic Information
System (GIS). The west end is generally representative of the island’s vegetation and land management; the rest of the island is, if anything, more impacted by feral animals and hydrologic alteration (see D. Knapp, “Oak ecosystem restoration on Santa Catalina Island, California: A synthesis of resources and threats,” this volume). A large continuous area such as the west end was chosen to census rather than sampling grid cells throughout the island because of the continuous, connected nature of oak habitat and the greater ease of such a method.

Within each UTM grid cell, the aerial photographs were studied for all decades prior to mapping, in order to assess differences in shadow, quality, and distortion from photography and orthorectification. Changes in oak cover were then assessed and mapped conservatively in order to account for photo quality differences. Where a difference in cover was noted, the perimeter of the oaks affected was mapped and the percent change was recorded. The beginning and end date of the change and cause, if obvious, were also noted in the GIS database. The resulting “loss” layer was then compared with a map delineating the full extent of *Quercus pacifica* habitat as of 2005, in order to quantify the percent of the habitat which has been lost. The latter map was produced for the entire island, and is a refinement of an earlier plant community map of Catalina (Knapp 2005). This 2005 *Quercus pacifica* map identifies oak habitat by delineating areas with 15 to 20% or more oak cover, with no more than 20 meters between individual oak trees.

**RESULTS**

Since the 1940’s, 159 hectares of oak habitat (i.e., including associated species between oaks) have been lost on Catalina’s west end; this is 61 hectares of oak cover alone (calculated based on the percent oak cover recorded). The decline was distributed throughout the west end of the island (Figure 1). No recruitment into the canopy layer (i.e., increase in cover) was noted to offset this loss. The total combined historical and current (2005) oak distribution on the west end is 510 hectares; therefore, 31% of the west end’s oak habitat has been lost between 1943 and 2005. *Quercus pacifica* habitat currently covers 4,425 ha. of the island (23%). If the decline on the west end was consistent with the rest of Catalina, oak habitat would have covered 6,413 ha. (33%) of the island in the 1940’s, a loss of 1,988 ha. over the past 60 years. Some, but not a major portion of the oak decline noted was due to clearing (1.88 ha), roads and trails (2.59 ha.). More of this type of disturbance was noted east of the Isthmus, particularly around the 1950’s; one example is shown in Figure 2. The majority of the loss on the west end was due to a gradual dieback, and the peak initiation of this loss was in the 1970’s (Figure 3).

**DISCUSSION**

A substantial percentage of oak habitat has been lost on the island’s west end since the 1940’s, while no mappable recruitment was noted during this time (i.e., trees that are large enough to distinguish on aerial photographs). Multiple factors have been correlated with a lack of oak tree regeneration in California, including overgrazing, deer browsing, acorn predation (including that by introduced wild pigs), fire suppression, exotic annual grass competition, summer drought, and canopy cover which is either too high or too low to provide a suitable environment for germination and growth (White 1966, Griffin 1976, Borchert et al. 1989, Danielsen & Halvorson 1990, Davis et al. 1991, Mensing 1992, Peart et al. 1994, Standiford et al. 1997, Swiecki et al. 1997b, Loggins et al. 2002, Standiford 2002). All of these factors could be causing reduced *Quercus pacifica* regeneration on Catalina. The effects of browsing and predation may be especially great on the island, where endemic plants such as *Q. pacifica* have evolved without the presence of native ungulates. Associated shrubs and trees in close proximity to oaks have been shown to facilitate successful oak regeneration (Callaway & D’Antonio 1991, Swiecki et al. 1997, Brooks & Merenlender 2001); a decline in shrub cover on Catalina may also have reduced this capability.

Figure 1. Distribution of *Q. pacifica* loss, along with current distribution, on the west end of the Island. Dates shown represent initiation of loss.

Figure 2. Historical photographs showing oak habitat loss due to clearing between 1952 and 1968, in the vicinity of Camp Cactus.

Figure 3. Hectares of *Quercus pacifica* lost by year the dieback was first noted.

This large-scale dieback could produce a feed back to reduce future regeneration, as research has suggested that fragmentation and thinning may reduce the availability of pollen and thus hinder reproduction (Knapp et al. 2001, Sork et al. 2002). The large decline in oak tree cover documented here should be mitigated through restoration plantings. The mapped areas of oak habitat loss produced from this study can be used to determine locations for future such efforts.

ACKNOWLEDGMENTS

The Seaver Institute provided funding for aerial images, which were obtained from: Whittier College, Continental Aerials, and UCSB Map and Imagery Center.
LITERATURE CITED


