



Eucalyptus spp. Alter Land Snail Species Assemblage

Michael Walgren, Lisa Andreano
Environmental Scientists
1 Lower State Park Road, Morro Bay, Ca, 93442
Phone: 805-610-1931 E-mail: mwalg@parks.ca.gov

Abstract

In San Luis Obispo County, forests of introduced eucalyptus were planted on a large scale in Montana de Oro State Park (MDOSP). Eucalyptus forests of *Eucalyptus globulus*, *E. cladocalyx*, *E. camaldulensis*, *E. cephalocarpus*, and *E. viminalis* occupy 61 hectares of Baywood fine sand soil in an area of high endemism of plants and animals in maritime chaparral and coastal dune scrub. These forests are believed to exclude numerous sensitive species, including the federally listed Morro shoulderband snail (*Helminthoglypta walkeriana*; MSS). In 2010 we used mapping layers of soil types, known occupied snail habitat, and predicted historic vegetation composition, to locate eucalyptus within predicted suitable MSS habitat. We then tested the hypothesis that eucalyptus alters the species composition of terrestrial pulmonate gastropods in the study area. Transects were established in suitable MSS habitat that extended from native coastal scrub into eucalyptus forests, and all snail species encountered along the transects were recorded. Thirty-seven MSS were found outside the eucalyptus canopy and one was found inside the eucalyptus canopy. When comparing eucalyptus forest areas with native vegetation areas we found that the snail species composition and abundance of each of the four snail species was significantly different. Study results showed that MSS were absent in eucalyptus forests located in otherwise suitable habitat within the occupied range, without correlation to specific eucalyptus species. Three other snail species increased in number within the eucalyptus forests. This research documents that the presence of eucalyptus forests at MDOSP is correlated with loss of suitable habitat for the MSS, alteration of land snail community composition, and increased abundance of three other snail species, two of which may prey on MSS.

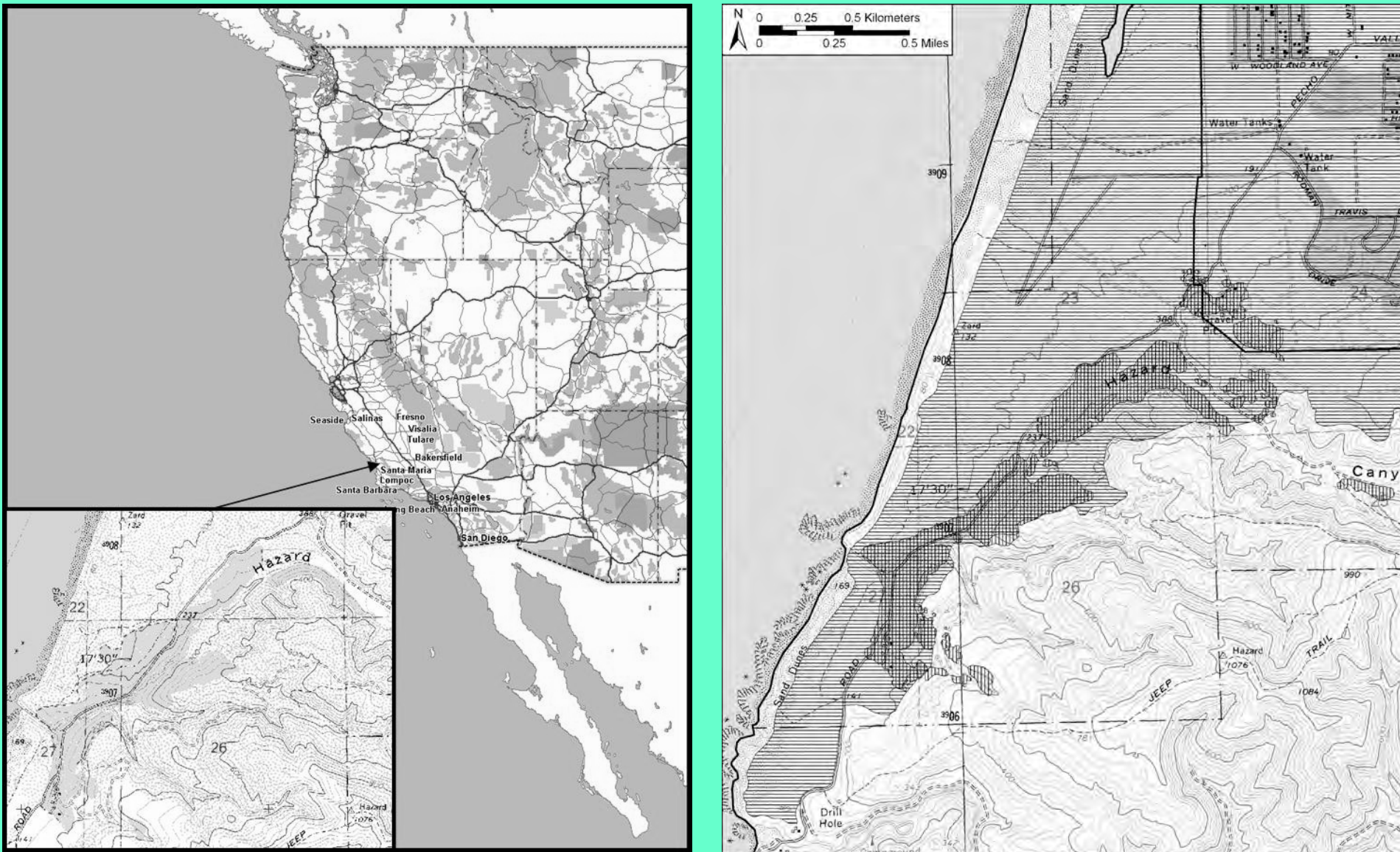


Figure 1. The left portion of the figure shows the relative location of the study site in relation to the United States western coast and an insert shows the study site. The right portion of the figure shows the distribution of eucalyptus forests (vertical shading) and Morro shoulderband snail habitat (horizontal shading) within Montana de Oro State Park and the neighboring community of Los Osos (the park boundary is shown as a darker line in the upper right).

Introduction

Casual observations at MDOSP in coastal San Luis Obispo County, California, revealed an absence of a native federally listed snail species within forests of introduced *Eucalyptus* spp. Given that previous research has shown species composition of various animal taxa was different between native (*Quercus agrifolia* and *Umbellularia californica*) and non-native (*Eucalyptus globulus*) woodlands (Sax 2002), we studied mollusk community composition differences between eucalyptus forests and adjacent native vegetation.

The MSS is a terrestrial mollusk listed as endangered under the federal Endangered Species Act. The endemic MSS is restricted to 7,600 acres on Baywood fine sands, a local ancient dune soil with high organic content, surrounding the Morro Bay estuary (USFWS 1998). The range of the MSS encompasses a eucalyptus forest, the community of Los Osos, and approximately 860 acres of open space. Habitat use by MSSsnails includes primarily sandy soils in coastal scrub and dune scrub (Roth & Tupin 2004), and to a lesser extent other mesic exposed habitats such as grasslands (Walgren 2003). Little is known about the biology or ecology of the MSS. Diet is expected to be focused on general vegetable detritus (Roth 1985).

The eucalyptus forest within the roughly 16,000 acre MDOSP consists of 158 acres (Figure 1) of contiguous stands of mixed eucalyptus species as well as monoculture stands of *Eucalyptus globulus*, *E. cladocalyx*, *E. camaldulensis*, *E. cephalocarpus*, and *E. viminalis*. These forests also occur on Baywood fine sands and are surrounded by native maritime chaparral and coastal scrub habitats. The forests were introduced in experimental plantation rows for commercial wood purposes in 1907 to determine the most appropriate species for the area. The plantations of each species of eucalyptus are planted in dense rows with a continuous canopy that creates a forest floor barren of vegetation and covered in dense eucalyptus litter and branches.

Methods

In 2010 the authors located eucalyptus stands nested within the boundaries of known MSS occupation, where soil type was Baywood fine sands, and coastal scrub or dune scrub was expected historically.

Transects consisted of ten 1 meter quadrats in native plant habitat and ten quadrats within the eucalyptus forest, each spaced ten meters apart. The canopy interface area was excluded in order to simplify comparisons between forest and non-forest areas. Within each quadrat, we thoroughly searched for snails within the litter, vegetation, and soil to approximately 2.5 cm depth.

All terrestrial pulmonate gastropods encountered were recorded, as was the plant community type. Data was collected during a single day at each transect. Data was only collected during dry conditions when snails would be expected to be aestivating and inactive (Roth 1985; USFWS 1998).

Figure 2. Photographs of the snails encountered, left to right: *Haplotrema minimum*, *Helminthoglypta umbilicata*, and *Oxychilus cellarius*



Figure 3. A typical understory view in the Eucalyptus forest. Note the lack of understory vegetation in an area that would have been shrubland historically.



Figure 4. Morro shoulderband snail, *Helminthoglypta walkeriana* (federally listed)

Results

Vegetation data collected outside the eucalyptus documented coastal scrub and dune scrub communities with varying levels of invasive perennial veldt grass (*Ehrharta calycina*), whereas vegetation within the eucalyptus forest was sparse or nonexistent.

We found 38 MSS shells in non-eucalyptus habitat and 1 MSS shell within the canopy edge of *E. cephalocarpa* (Figure 2). Statistical analysis (Table 1) demonstrated a negative correlation between the presence of eucalyptus forests and the presence of MSS.

The terrestrial pulmonate mollusk species composition and individual species abundance also differed within and outside the eucalyptus forests (Figure 2). While MSS decreased inside forests, three other species were more abundant within the forests: Big Sur shoulderband snail (*Helminthoglypta umbilicata*), cellar glass-snail (*Oxychilus cellarius*), and California lancetooth (*Haplotrema minimum*). *Oxychilus cellarius* was introduced from Western Europe and is closely associated with human habitation and introduced landscapes (Pilsbry 1939), feeding on plant material and the eggs of other snails, slugs, and earthworms (Mason 1970; White 2011). *Haplotrema minimum* is a predator of other snails, including *Helminthoglypta* species (Pilsbry 1939). *Helminthoglypta umbilicata* is a sympatric native species found over a wider range of habitats than are associated with MSS.

Discussion

The altered pulmonate terrestrial gastropod species composition and varying abundance of four species identified within and outside the eucalyptus forests demonstrates community-level impacts of an introduced habitat type. Impacts to snails include alterations of species composition, species abundance, and the balance of predator and prey snail species. Land managers and regulatory agencies interested in conservation of native biodiversity should prevent the expansion or establishment of eucalyptus forests within conserved lands and consider habitat restoration of current eucalyptus stands, particularly when a rare endemic species is impacted.

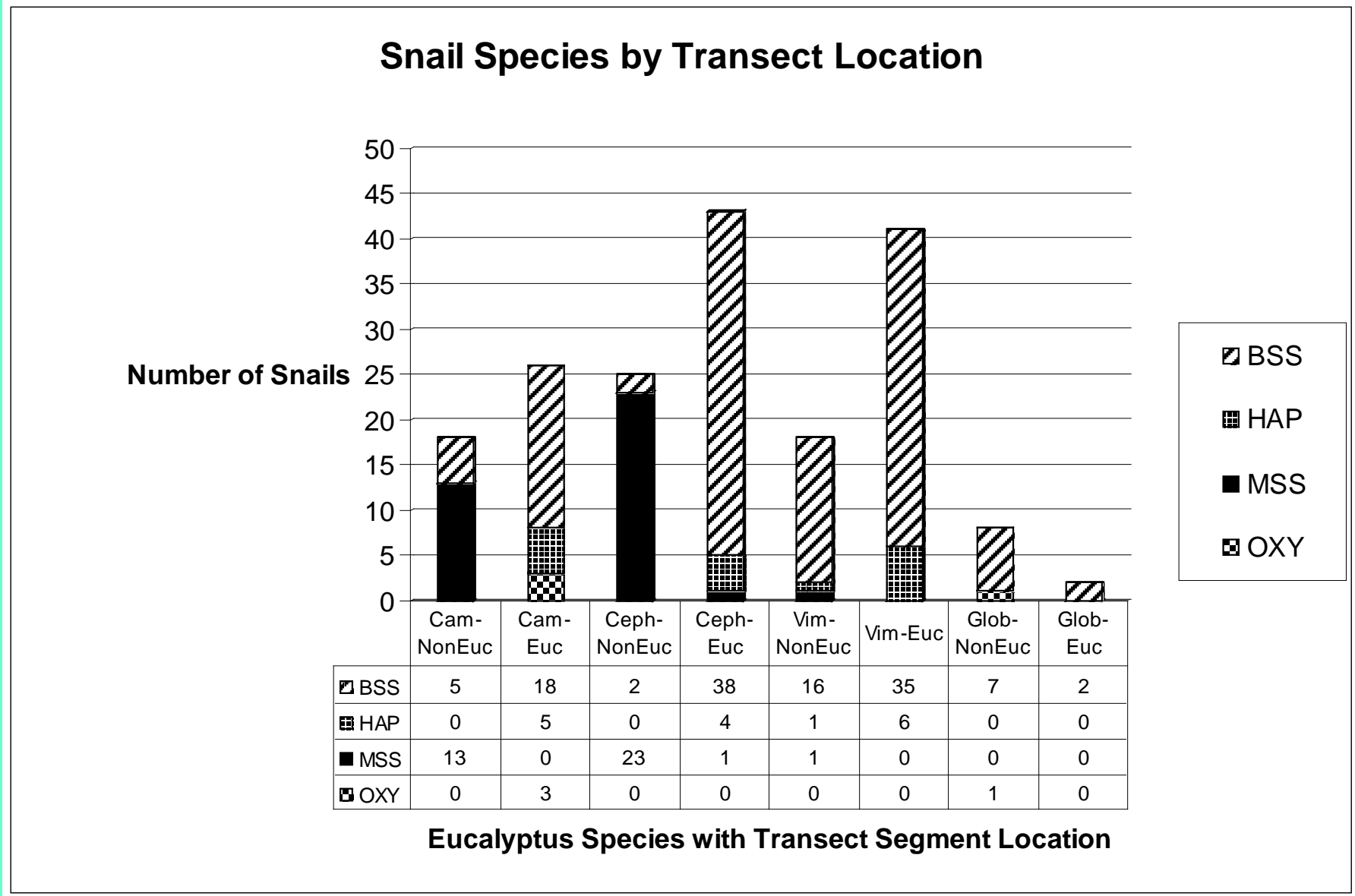


Figure 4. Number of snails by species in each segment of the transects: “NonEuc” indicates the transect portion outside the eucalyptus forest, while “Euc” indicates within the forest. Eucalyptus species are abbreviated as follows: Cam=*E. camaldulensis*, Ceph=*E. cephalocarpa*, Glob=*E. globulus*, and Vim=*E. viminalis*. BSS=*Helminthoglypta umbilicata*, HAP= *Haplotrema minimum*, MSS=*Helminthoglypta walkeriana*, OXY=*Oxychilus cellarius*.

Euc. Species	No. MSS Inside Euc	No. MSS outside Euc	Exact Test p-value
<i>E. camaldulensis</i>	0 (N=20)	13 (N=20)	p=0.000
<i>E. viminalis</i>	0 (N=20)	1 (N=20)	p=1.000
<i>E. cephalocarpa</i>	1 (N=20)	23 (N=20)	p=0.000
<i>E. globulus</i>	0 (N=20)	0 (N=20)	N/A
All Euc. Combined	1 (N=80)	37 (N=80)	p=0.000

Table 1. Results of the two-sample Poisson rate test for difference in the number of Morro shoulderband snails, by eucalyptus species, both inside and outside the eucalyptus forest. N=the number of quadrats per eucalyptus species. Levels of significance were measured at p<0.05.



Figure 5. Examples of native habitats used by MSS. These are the predicted habitats that occurred prior to eucalyptus introduction at Montana de Oro State Park. The left three photographs show local coastal dune scrub on Baywood fine sands and with many openings in the vegetation, often covered in lichens. The right photograph shows the local coastal scrub.

Further Research

Specific reasons why eucalyptus forests exclude MSS are not known, but are expected to include alterations in the availability of necessary vegetable detritus and increased predation and competition by other snail species. Alterations of light, moisture, soil chemistry, and physical attributes may also contribute to the exclusion of MSS within the eucalyptus forests. Other species of snails may be increased within the forests due to a wider dietary tolerance combined with increased moisture (which is generally associated with each of the increased species).

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