

Is western juniper (*Juniperus occidentalis*) dispersed through diplochory?



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Figure 1. Three species of frugivorous birds that disperse western juniper seeds: (A) Townsend's solitaire (*Myadestes townsendi*), (B) American robins (*Turdus migratorius*), and (C) cedar waxwings (*Bombycilla cedrorum*).



Figure 2. The 2 field sites in northeastern California: Shinn Peak and Likely



Figure 3. Photos from trail camera set during seed removal trial showing different species that removed seeds and/or cones: (A) and (B) *Peromyscus* spp., (C) and (E) *Spermophilus beecheyi*, (D) *Dipodomys californicus*, (F) *Tamias amoenus*.

Introduction

Throughout its native range, western juniper (*Juniperus occidentalis*) has been encroaching into shrublands and increasing in density for over a hundred years due to factors such as fire suppression, grazing, and climate change. Understanding the seed dispersal process of this tree is necessary to comprehend some of the mechanisms underlying this expansion. Western juniper is regarded as dispersed by frugivorous birds (Figure 1) with rodents generally considered to be seed predators. After a mast year, bird feces filled with juniper seeds blanket the ground, potentially providing an easily accessible seed resource for granivorous rodents. We sought to understand if rodents are important dispersers of western juniper seeds, whether acting as primary and/or secondary dispersers (i.e. caching bird passed seeds) in a two-phased seed dispersal system (diplochory). In a preliminary study we compared the removal of hand cleaned juniper seeds, bird passed seeds and whole berries (or cones) from enclosures in northeastern California.

Methods

- ❖ Two field sites in northeastern California (Figure 2)
- ❖ 3 treatments, 100 seeds each: bird passed seeds, hand cleaned seeds, whole cones
- ❖ 3 enclosures at 2 sites: one side accessible to birds, one side with access for small mammals
- ❖ Trail cameras above enclosures to identify species (Figure 3)
- ❖ Seed removal was monitored until most of seeds have been taken or removal has slowed
- ❖ 2 trials: June 2011 and July 2013

Results

- ❖ Shinn Peak 2011: on the side of the enclosures that small mammals had access to, seeds were removed more rapidly than berries and the mean number of seeds left was lower (53 for bird passed seeds and 6 for hand cleaned seeds) than for berries (77.6).
- ❖ Likely 2011: small mammals removed berries more quickly than seeds with the mean number of berries left (1) being lower than the mean number of seeds remaining (28 for bird passed seeds and 8.3 for hand cleaned seeds).
- ❖ Birds did not remove any berries or seeds at Shinn Peak and only removed 13 seeds from one enclosure at Likely in 2013
- ❖ Shinn Peak 2013: there was no removal
- ❖ Likely 2013: in the side of the enclosure accessible to small mammals, the mean number of hand cleaned seeds left (23) was the lowest, followed by bird passed seeds (33.3) and then cones (53.3). There was no removal of seeds by birds and the mean number of cones remaining was high (95.7).
- ❖ After reviewing the trail cameras, we found that *Spermophilus beecheyi* was responsible for the vast majority of berry removal at Likely. *Peromyscus* spp. were also recorded at Likely removing mainly seeds.
- ❖ *S. beecheyi* is not present at Shinn Peak and generally acts as a seed predator.
- ❖ At Shinn Peak, *Peromyscus* spp. and *Tamias amoenus* were recorded removing seeds and berries from enclosures. Both *Peromyscus* and *Tamias* are known to cache seeds in a variety of conifer species. Many pictures of *Dipodomys californicus* were captured outside of enclosures.

Discussion

These preliminary results indicate that seed caching rodents prefer seeds, including those defecated by frugivorous birds, over berries and can potentially act as dispersers of western juniper. Although birds did not remove seeds or berries during these trials, in previous trials using only berries in these same enclosures, birds entered the enclosures and rapidly removed berries (Figure 4). However, these previous trials were performed in late winter and early spring when robins, solitaires and waxwings are still abundant and can be seen feeding on juniper berries in trees. The lack of removal at Shinn Peak in July of 2013 could be due to the abundance of alternative seed sources such as *Purshia tridentata* seeds. We hypothesize that secondary dispersal by rodents might vary seasonally. In the late fall, winter and early spring, when juniper cones are still on trees and are being consumed by birds, juniper seeds likely comprise a larger portion of a granivorous rodent's diet than during the summer when there are a variety of other seeds available. If the removal and subsequent caching of bird passed seeds by granivorous rodents leads to seedling recruitment of western juniper, this two phase seed dispersal system is an example of diplochory (Figure 5). Diplochory could be beneficially by moving seeds farther from the parent plant, away from conspecifics to targeted microsites, where, after being buried, juniper seedlings have a higher chance of survival. Future studies will involve repeating this experiment in the winter and early spring, tracking seeds after removal to determine if rodents aid in seedling recruitment and determining which granivorous rodent species are contributing most to the recruitment of seedlings.

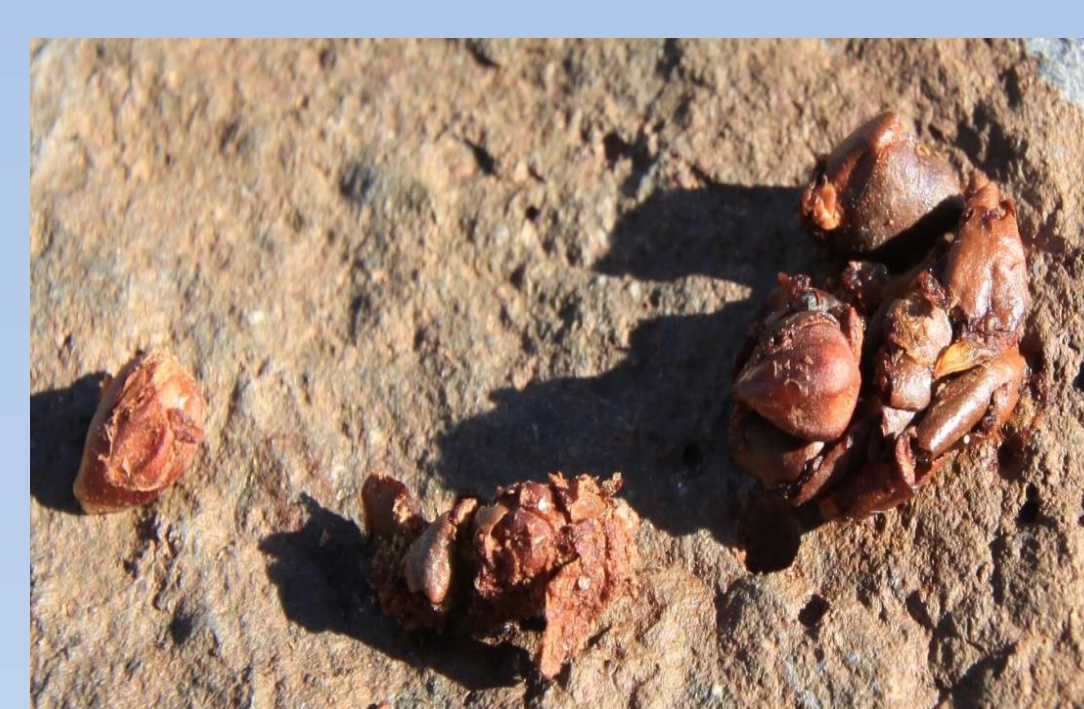


Figure 4. Trail camera pictures of robins removing berries from two different enclosures

Figure 5. Possible seed dispersal system of western juniper. This diagram represents two non-conflicting seed fates (it is not an exhaustive depiction). In the first scenario, the seed is dispersed through diplochory, where phase 1 and 2 involve different dispersal agents (frugivorous birds such as cedar waxwings (A) and granivorous scatter-hoarding rodents such as yellow pine chipmunk, *T. amoenus* (B)). In the other scenario, granivorous rodents, *Peromyscus truei* (C), remove cones from below parent trees, husk the seeds from the cone and cache them. Diplochory can benefit a plant by moving a seed even further from its parent plant than phase 1 alone, and when scatter-hoarding rodents are the secondary dispersal agents, additional benefits to the plant can include burial of seeds which can decrease desiccation and reduce the risk of predation.



PHASE 1



PHASE 2



Secondary dispersal agent



Scatter-Hoarded Cache



Germination



Seed Mortality

Relevant Literature

- ❖ Adams, R.P. and D. Thornburg (2010) Seed dispersal in *Juniperus*: a review. *Phytologia* 92:424-434
- ❖ Vander Wall S.B. and W.S. Longland (2004) Diplochory: are two seed dispersers better than one? *Trends in Ecology and Evolution* 19:155-161
- ❖ Rowland, M.M., L.H. Suring, R.J Tausch, S. Geer, and M.J. Wisdom (2011) Characteristics of western juniper encroachment into sagebrush communities in central Oregon. *Natural Resources and Environmental Issues: Vol. 16, Article 13*

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