



# The impact of invasion and removal of *Lupinus arboreus* on seedbanks in coastal sand dune environments

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## INTRODUCTION

### SEEDBANK STUDIES

- Seedbanks provide a signature of previous plant communities, while also allowing prediction of future plant communities (3).
- Seedbank studies have been used to determine the long-term impacts of invasive species by showing the percentage of native or exotic seeds present within the soil.

### RESTORATION

- Restoration of biological communities typically focuses on restoring plants to the aboveground community, yet the legacy of previous degradation may still be present in the belowground plant community (e.g. the soil seedbank).

### INVASIVE SPECIES

- Lupinus arboreus* (yellow bush lupine; Fig. 1) is a nitrogen fixing shrub that has invaded coastal dunes of Northern California where it alters the chemical composition of the soil (1).
- The change in chemical composition promotes further invasion of other exotic species, particularly annual grasses (2).
- Due to increased competition with exotic species, the unique native species of the coastal dune environment often experience a decrease in potential habitat and cover within the coastal dune ecosystem (2).



Figure 1. Flowering *Lupinus arboreus* (U.S. Fish & Wildlife Service).

### OBJECTIVES

- The goal of our research is to assess the effectiveness of dune restoration in removing *L. arboreus* aboveground by quantifying differences in seedbanks among three sites:
  - A *L. arboreus* invaded site (Lupine site).
  - A restored site (Restored site).
  - A site never invaded by *L. arboreus* (Natural site).

## METHODS

### SITE DESCRIPTION

- Lanphere Dunes in Arcata, CA is managed by the US Fish & Wildlife Service (Fig. 2).
- Lupine site vegetation consisted of mostly *L. arboreus*, *Baccharis pilularis*, and annual grasses with a small percentage of bare ground (Fig. 3).
- Restored site vegetation consisted of native forbs, exotic forbs, and annual grasses with a high percentage of bare ground (Fig. 3). This site had *L. arboreus* removed annually since 1999.
- Natural site vegetation consisted of native forbs with a high percentage of bare ground.

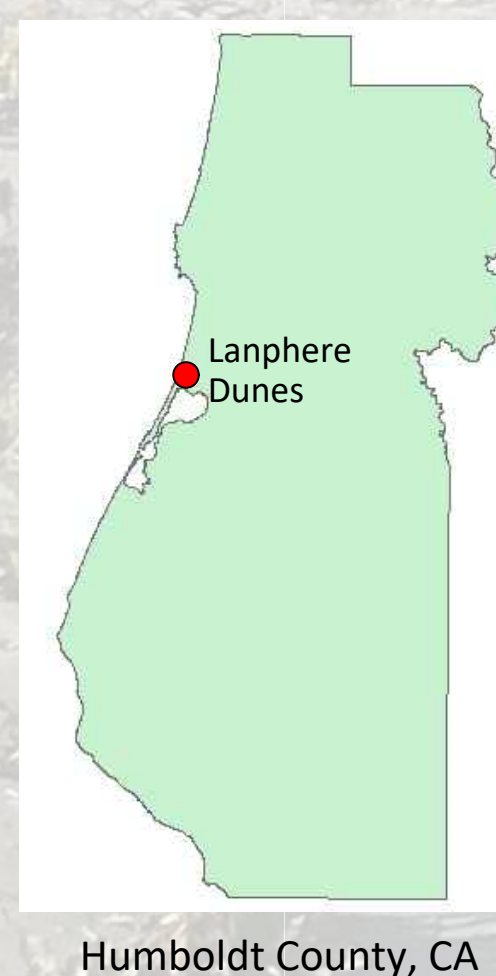


Figure 2. Location and Site Map of Lanphere Dunes with sampling sites.



## METHODS cont.

### SEEDBANK

#### Seedbank Samples:

- We collected twenty 37.5 cm<sup>3</sup> soil samples at each site.
- We collected Lupine site samples beneath mature *L. arborues* shrubs (Fig. 3).
- We collected Restored and Natural site samples at randomly selected coordinates along a transect, within 30 cm of live vegetation (Fig. 3).

#### Seedbank Germination:

- We sieved each soil sample (Fig. 3) and poured each sample to a depth of 1 cm over a sterile sand substrate in three 8.5 cm<sup>3</sup> plastic pots.
- Plastic trays held fifteen randomly-placed plastic pots (Fig. 4).
- Trays were cycled and watered 2-3 days a week within the Humboldt State glasshouse.



Figure 3. Measuring distance from the transect point to the vegetation at Restored site (left). Collecting samples at Lupine site (middle left). Sieving soil samples to remove large organic matter (middle right). Lupine site sample pot #29 at day 18 (right).

### DATA

- We visually inspected pots and recorded any new germinated individuals every 2-3 days for 47 days.
- Prior to analysis, we assigned plants to one of two functional groups: forbs or graminoids.
- We compared mean daily germination rates using regression analyses and mean plant abundance among sites using ANOVAs.

## RESULTS

### GERMINATION RATES

- Seedlings first emerged on day 3 and continued through day 47 (Fig. 5).
- Restored site had greatest total mean daily germination rate (0.23 plants/day), while Lupine site had lowest total mean daily germination rate (0.12 plants/day; Fig. 5A).
- Restored and Natural sites had identical mean daily forb germination rate (0.15 forbs/day), while Lupine site had a lower mean daily forb germination rate (0.10 forbs/day; Fig. 5B).
- Restored site had highest graminoid mean daily germination rate (0.08 graminoids/day), while Natural site had lowest graminoid mean daily germination rate (0.01 graminoids/day; Fig. 5C).

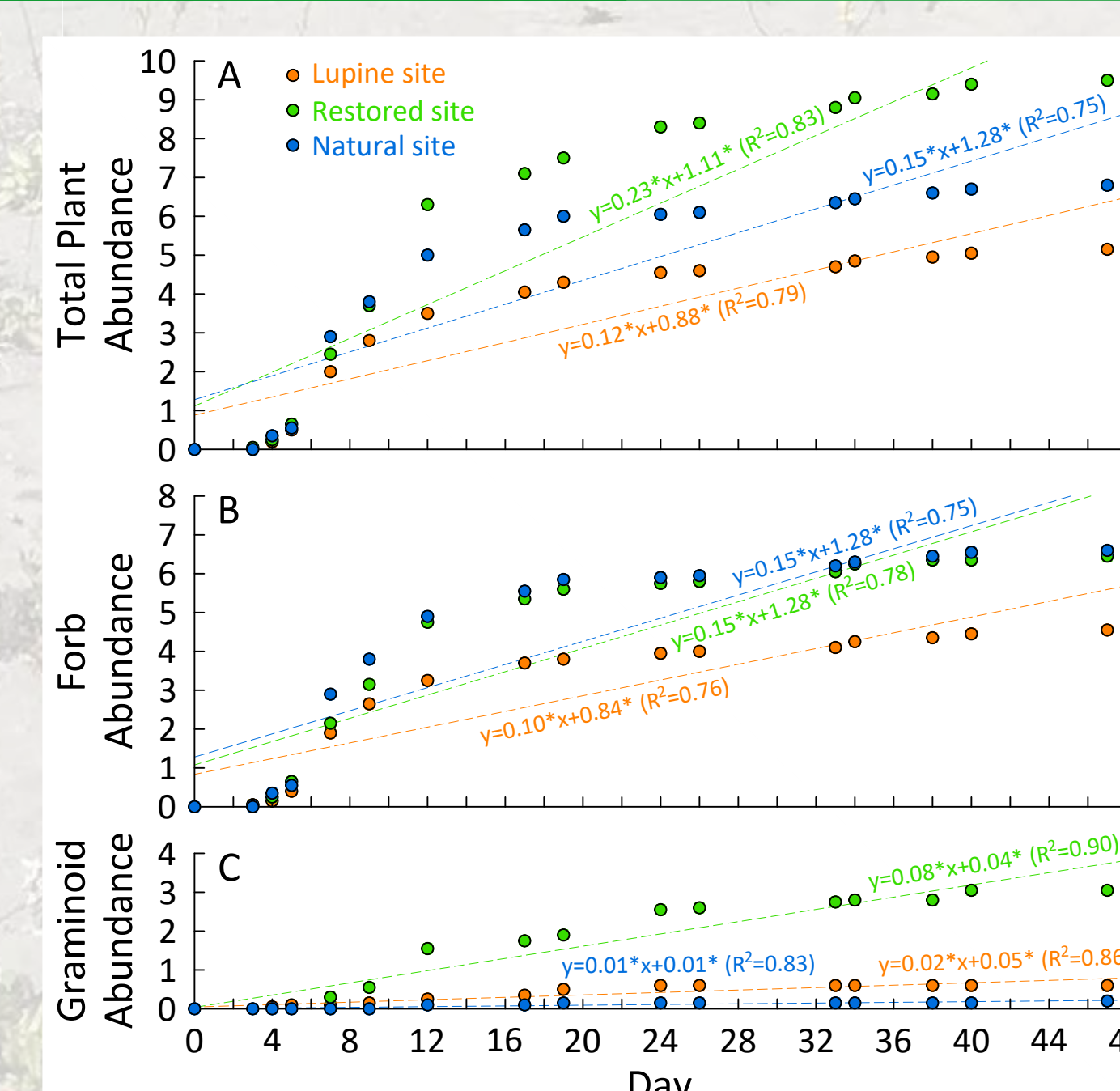


Figure 5. Total plant germination (A), forb germination (B), and graminoid germination (C) over time at each site. Equations represent the line of best fit for daily germination rates at each site. \* indicates  $p < 0.001$ .

## RESULTS cont.

### PLANT ABUNDANCE

- Across all sites, the relative abundance of forbs was much greater than the relative abundance of graminoids (Fig. 6).
- Restored site had greatest mean total abundance (9.50 plants), while Lupine site had lowest mean total abundance (5.15 plants; Fig. 7).
- Natural site had greatest mean forb abundance (6.60 forbs), while Lupine site had lowest mean forb abundance (4.55 forbs; Fig. 7).
- Restored site had greatest mean graminoid abundance (3.05 graminoids), while Natural site had lowest mean graminoid abundance (0.20 graminoids; Fig. 7).
- Both mean total and mean forb abundance did not differ significantly among the three sites ( $p=0.44$  and  $p=0.62$  respectively; Fig. 7).
- The difference in mean graminoid abundance was slightly significantly among the three sites ( $p=0.09$ ; Fig. 7).

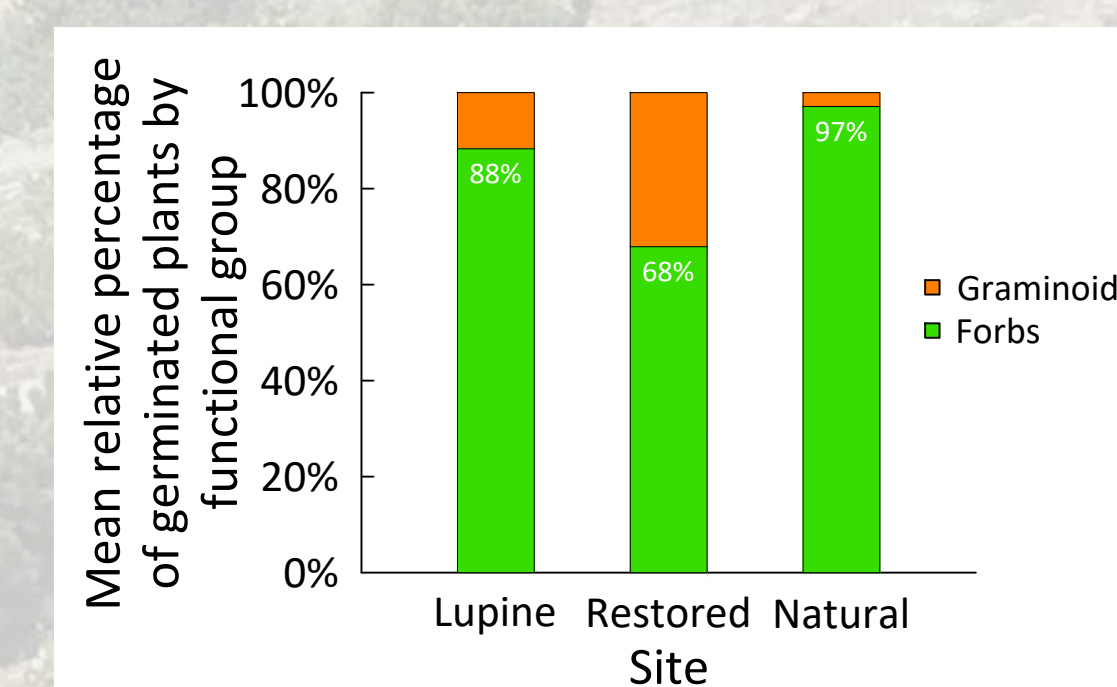


Figure 6. Comparison of the percentage of forb and graminoids found at each site.

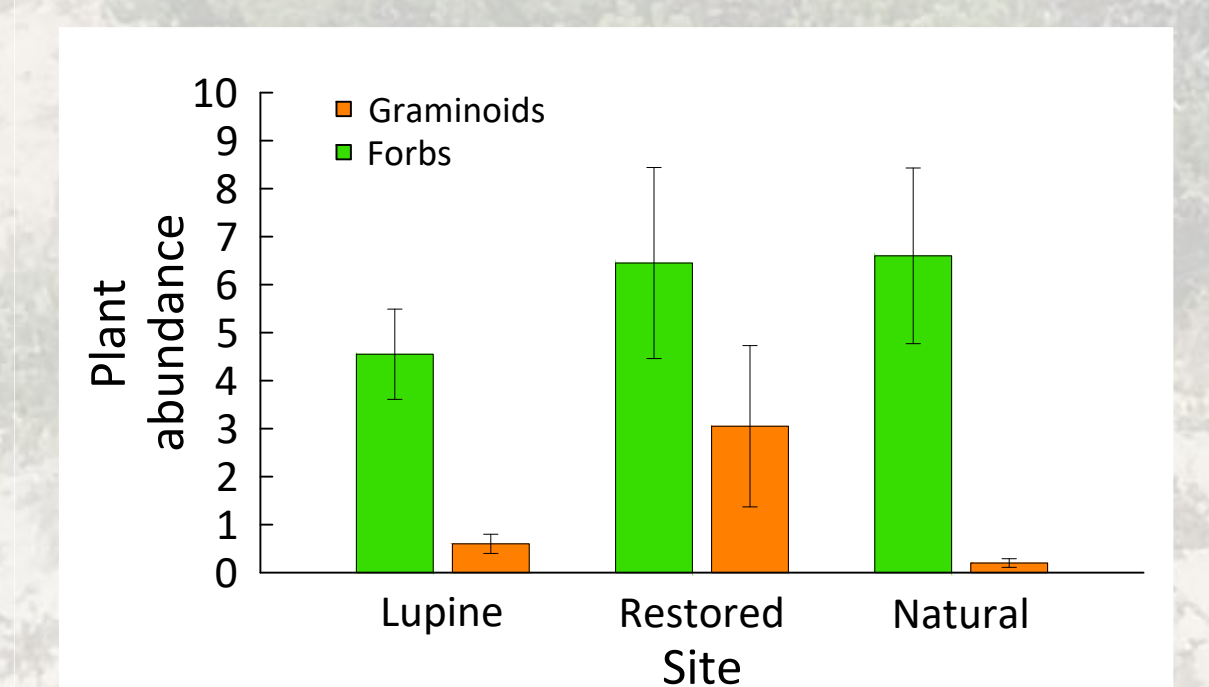


Figure 7. Mean forb and graminoid abundance at each site. Bars represent standard error.

## DISCUSSION

### CURRENT RESEARCH

- We expected Lupine site to have greatest total plant abundance due to more plant-available nitrogen, and it had the lowest total plant abundance. This may indicate that *L. arboreus* reduces abundance of viable seeds in the seedbank.
- Forb abundance did not differ significantly and was not expected to.
- Greater graminoid abundance in Restored site may be explained due to graminoids taking advantage of greater plant-available nitrogen than Natural site and greater bare ground (e.g. less competition) than Lupine site.

### CONTINUING RESEARCH

- Germination is ongoing and soil surfaces will be scraped to encourage additional germination.
- Each plant will be identified to species and separated into native or exotic plants.
- We will analyze the abundance and richness of plants at each of the sites to understand how *L. arboreus* may be impacting the seedbanks of the coastal dunes.

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