

**Nipomo Lupine (*Lupinus nipomensis*) 2022-23 Year
Outplanting and Assessment Studies**



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Introduction

During the 2019-20 hydrologic year several projects were initiated which were designed to evaluate questions resulting from the long-term Black Lake Ecological Area (BLEA) Nipomo lupine seeding experiment. These include an assessment of soil conditions at various sites, an assessment of soil moisture at multiple sites and two additional experimental outplanting trials to evaluate the extent to which fog collection by cages could be more of a factor than herbivory-protection and to evaluate whether there are any benefits to lupine survival from growing ‘with’ versus ‘without’ other plants nearby. Results from those studies were compiled in the 2019-20, 2020-21, and 2021-22 reports.

This report covers results from the monitoring of the two experimental trials over the 2022-23 winter, which was relatively wet compared to the previous few years. This report also covers the Year 2 monitoring of the 2021-22 augmentation effort which included 23 plots each seeded with 500 seeds established in the swales at BLEA (2014/15 trial swale and 2019 trial swale) and Kathleen Goddard Jones Overlook swale (KGJO). An additional 6 augmentation plots were added to BLEA in 2022, as well as 10 plots at the Dune Protected Area (DPA) just west of Phillips 66 refinery. These plots included modest variation to further track the pros and cons of seed scarification and fencing/caging as well as parallel camera trap studies designed to document seed predation and plant herbivory.

Finally, this report includes a brief update on a small occurrence of lupine growing in the Cal Trans right of way along Willow Road near the entrance to the Phillips 66 refinery. This naturally occurring subpopulation was monitored twice near the middle and end of the growing 2022-23 growing season for the number of individuals and seedpods.

The three study areas, as well as the Cal Trans subpopulation, occur within one square mile of each other within the Guadalupe-Nipomo sand dune complex (Figure 1).

Nipomo Lupine Study Areas

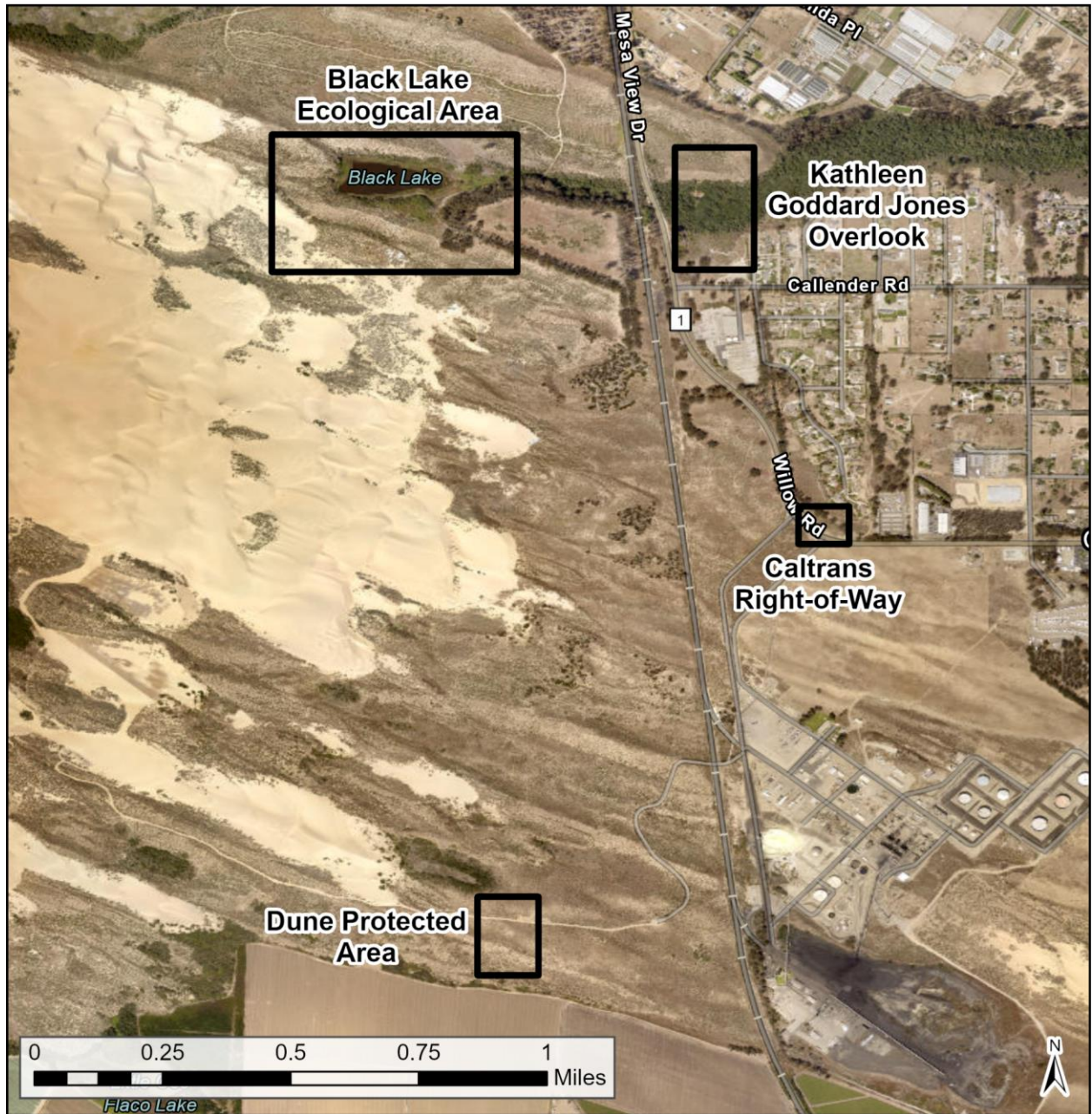


Figure 1. Map of Nipomo lupine experimental sites.

Experimental Outplanting Trials

Two questions arose in discussions with the recovery team regarding the results of the initial outplanting experiments from BLEA from 2014-15 and 2015-16:

1. Could the uncaged plots where lupine seeds were vulnerable to herbivory have been negatively impacted by the fact that there was no mesh enclosing the seedlings that could potentially capture fog moisture?
2. Some lupine seedlings have been observed germinating within the shade or immediately adjacent to veldt grass (*Ehrharta calycina*) and other potential competitors. Could other plants play a facilitative role for Nipomo lupine?

To address these questions two trials were designed. The first is called “Fog versus Herbivory” which essentially creates an opportunity for lupine seedlings to receive potential additional fog dripping off of a meshed enclosure (e.g. a cage with a mesh roof) but which also allows herbivory by lifting the cage above the ground by 5 inches. This project demonstrates whether the lack of seedlings in the uncaged treatment from earlier studies was due to herbivory or to reduced fog inputs and lower soil moisture conditions. The second experiment was designed to protect all plants from herbivory in cages but evaluates competition by placing seeds in completely cleared/weeded plots and other seeds within a matrix of existing vegetation where weeds are not pulled. This allows us to address whether lupine germination, growth and seed production benefit from some intermittent clearing or disturbance to open the site and, alternatively, whether adjacent plants provide some reduced solar insolation or facilitate growth of the lupine plants.

The “fog versus herbivory” experiment was established at Black Lake Ecological Area (BLEA) and included five pairs of caged plots in each of three topographic positions (south facing, north facing and swale) in which 1 cage in each pair was lifted 5 inches off the ground to allow for small mammal/bird herbivory while retaining the cage and to potentially allow for fog drip from cage mesh tops and sides (Figure 2, Map; Figure 3 photos).

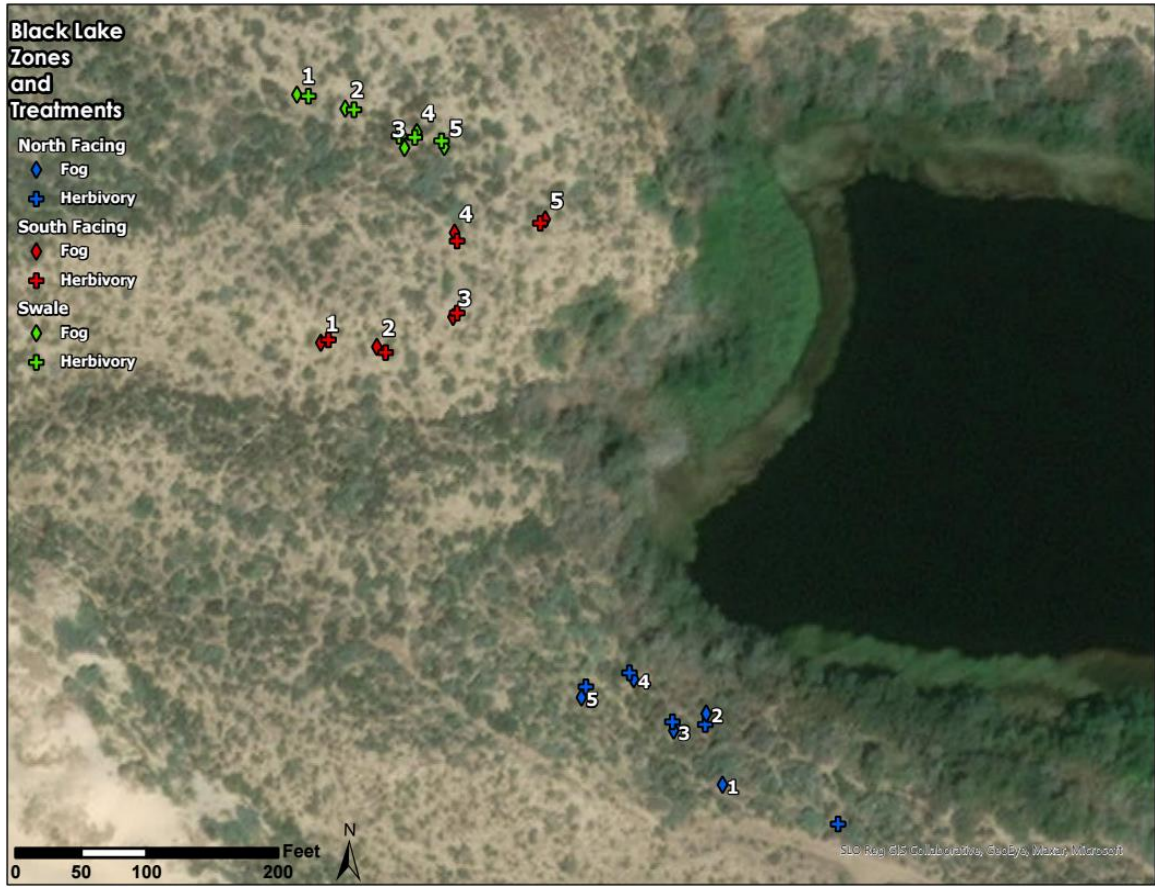


Figure 2. Map of Fog vs Herbivory Trial at Black Lake Ecological Reserve.



Figure 3a. Raised cage. Collects fog and allows for herbivory.



Figure 3b. Fully caged to collect fog and prevent herbivory.

The second 2019-20 experimental trial is the competition/facilitation experiment which was conducted in the swale at Kathleen Goddard Jones Overlook (KGJO) site where 5 pairs of cages were established at three topographic positions (south facing, north facing and swale sites) (Figure 4). One of each pair of cages was fully weeded and the other was established within a matrix of non-native grass or native shrubs.

The 2020-21 and 2021-22 reports on the Nipomo lupine Augmentation and Experimental Trials cover results from the first three years of monitoring of these two trials. This report, which covers Year 4 of the experiment, includes results for these trials and the augmentation effort.

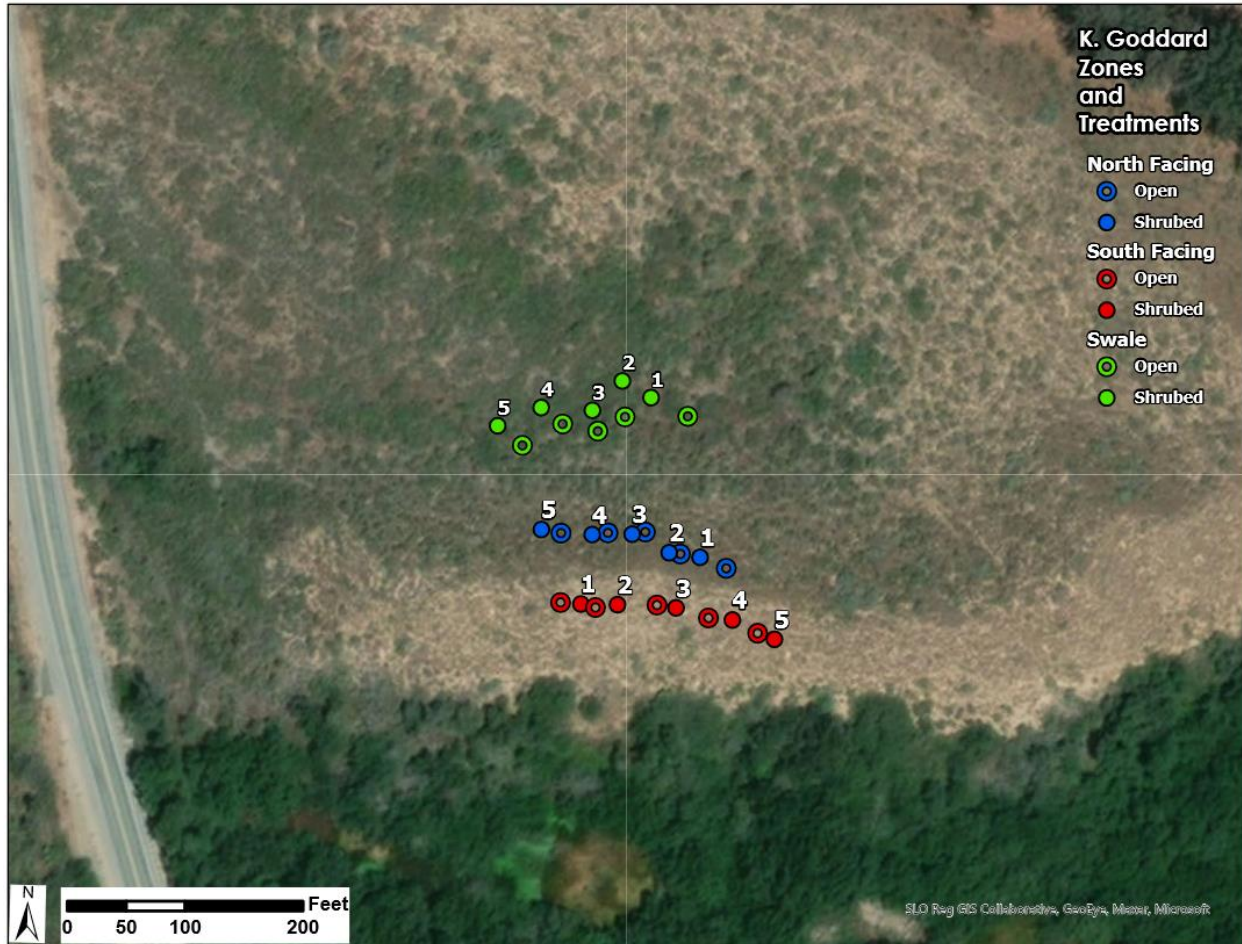


Figure 4. Experimental plots at Kathleen Goddard Jones Overlook comparing with vegetated, un-weeded (+ competition, “shrubby”) with cleared and regularly weeded (- competition, “open”) treatments within caged plots.

22-23 Monitoring Results: Fog vs. Herbivory.

The fog and herbivory trial at Black Lake Ecological Area confirmed that herbivory is a factor in germination and reproductive output (Figure 5). Despite both treatments (caged and lifted cages) having similar fog-catching capacity from the cages, the lifted cages had no germination and thus significantly lower seed pod production (zero production, $p = 0.030$) compared to the average seed pod production of caged plots of 5.1 ± 2.5 pods per plot. Caged plots also had a significantly higher proportion of germinants that reached reproductive maturity (~19.2%) compared to lifted cages (0%; $p < 0.001$). There was no significant difference in germination ($p = 0.442$) or seed pod production ($p = 0.226$) associated with topography.

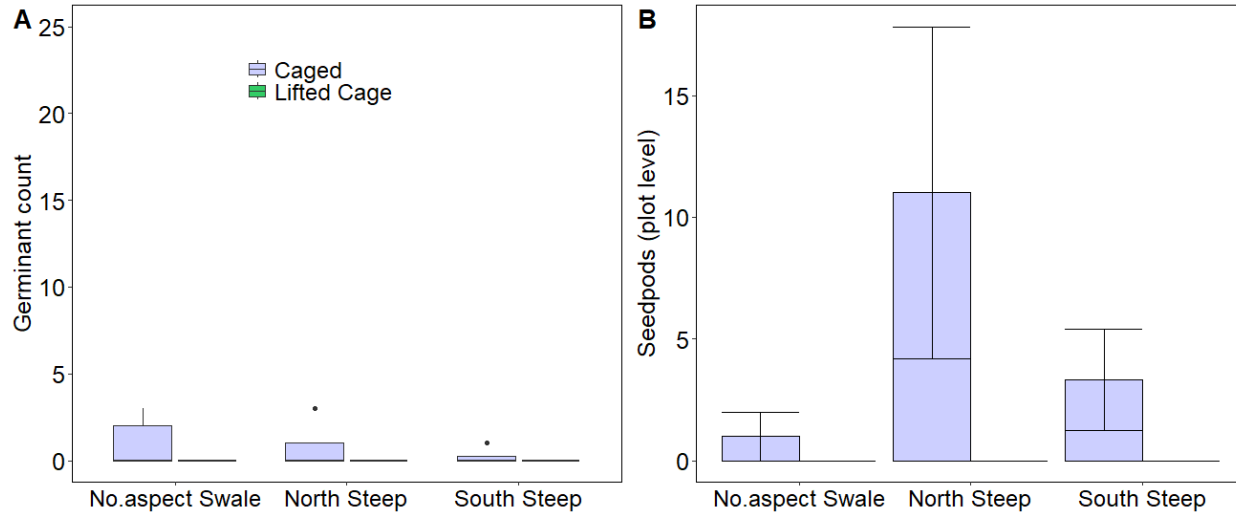


Figure 5. (A) Average germinant count and (B) average seedpod production by plot, topography and caging treatment from 2022-23 data.

We also monitored non-lupine plant cover in all plots and noted that the lifted cages showed evidence of herbivory by having significantly lower non-native cover ($p = 0.009$), but not specifically *Ehrharta calycina* ($p = 0.674$). The caging treatment did not affect native cover ($p = 0.458$). In the previous year, lifted cages had lower vegetation cover for both natives and non-natives. The relatively wet winter in 2022-23 may have contributed to greater vegetation cover in both lifted and non-lifted cages despite the effect of herbivory pressure.

22-23 Monitoring Results: Competition/Facilitation.

In the Kathleen Goddard Jones Overlook trial that compared caged cleared/weeded and vegetated/control plots, we found that neither germination ($p = 0.415$) nor seed pod production ($p = 0.316$) by plot was different between cleared/weeded and vegetated/control plots (Figure 6). In previous years, topography did produce significantly different results, with swale plots having higher germination and seed pod production than north or south facing slopes. However, in year 4, topography had no effect on germination ($p = 0.135$) nor seed pod production ($p = 0.172$). In 22-23, steep sites had little to no germination with the exception of one outlier north-facing plot driving all the seed production in that treatment, whereas there were multiple swale plots with high germination and seed production. When analyzed over all four years of the project, we find that swale plots do produce more germinants ($p = 0.026$) and seed pods ($p = 0.051$) than steep slope plots. It may be that in dry years, the effect of topography has more of an influence on germination and survival to seedset.

There were four plots in particular (three in the swale, and the outlier north-facing plot) that represented the majority of lupine at KGJO, with abnormally dense germination. In swale plot 1A, 664 individuals were counted within ~half a square meter (Figure 7). While there was

relatively high early seedling die-off within these plots due to crowding, many lupines survived to set seed.

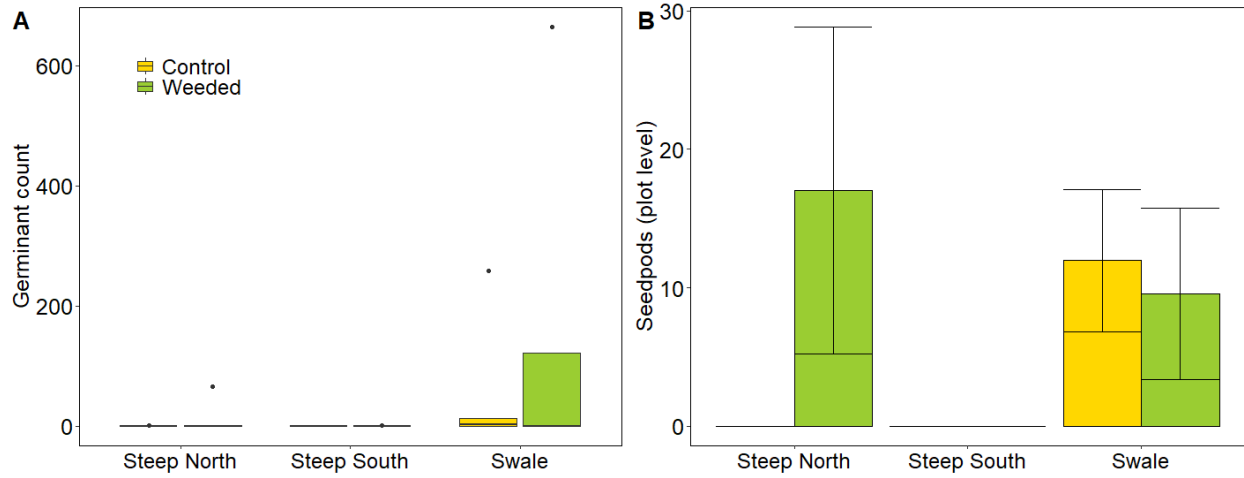


Figure 6. (A) Average germinant count and, (B) average seedpod production by plot, topography and weeding treatment from Year 4 data at KGJO.



Figure 7. Photo of plot 1A in the KGJO swale on 4/28/2023, showing unusually high seedling density.

2022-23 Monitoring and Weeding Activities

The KGJO plots that were weeded/cleared were weeded throughout the growing season while the vegetated/control plots were not weeded at all. At Black Lake only veldt grass and narrowleaf iceplant (*Conicosia pugioniformis*) were pulled from the plots when time allowed.

All trials were monitored in the 2022-23 year every two to three weeks for lupine germination, survivorship and reproductive output. In the late spring/early summer, percent cover and average height of all non-lupine species were estimated for each plot at both KGJO and BLEA. The relatively wet winter contributed to a superbloom of native sand dune wildflowers in the spring, many of which were growing within experimental and augmentation plots alongside Nipomo lupine (Figure 8).



Figure 8. Photo of augmentation plot 5 at DPA on 4/28/2023 containing blooming Nipomo lupine, purple owl's clover (*Castilleja exserta*), miniature suncup (*Camissoniopsis micrantha*), common cryptantha (*Cryptantha clevelandii*), blue toadflax (*Nuttallanthus texanus*), and seaside fiddleneck (*Amsinckia spectabilis*).

Augmentation Plots 2022-23

In early December 2021, we established 23 ten by ten-foot plots in the swales at BLEA (18) and KGJO (4) as well as one plot at the overlook area at KGJO. Each plot was seeded with 500 seeds. Experimental components included 1) comparing scarified and unscarified seeds within cages (8 plots of each treatment); 2) comparing caged and uncaged plots with scarified seeds (6 of each in the BLEA swales). We also compared performance between the KGJO swale and the BLEA swales (both the 2014/15 trial swale and the 2019 trial swale) with 9 plots in each of the BLEA swale areas and 4 plots in the KGJO swale. After the results of the 21-22 season showed the scarified, caged augmentation plots performed better, an additional six of such plots were installed at BLEA in fall 2022 (3 in each swale) (see Figure 9).

Nipomo Lupine BLEA-19 Augmentation Plots

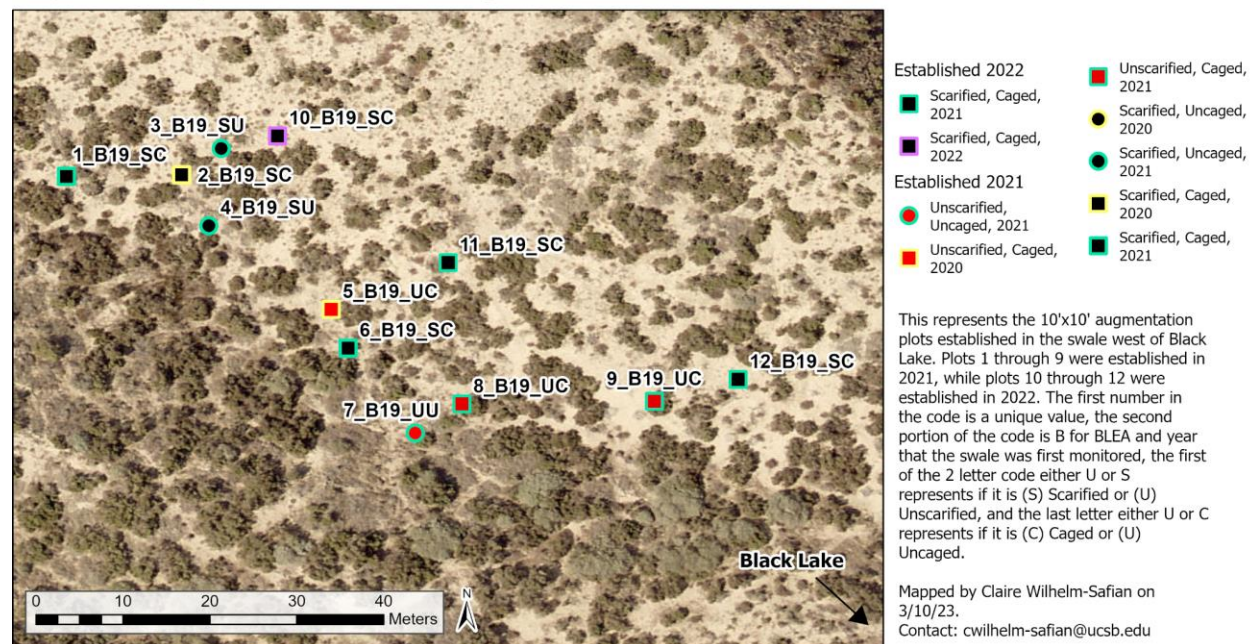
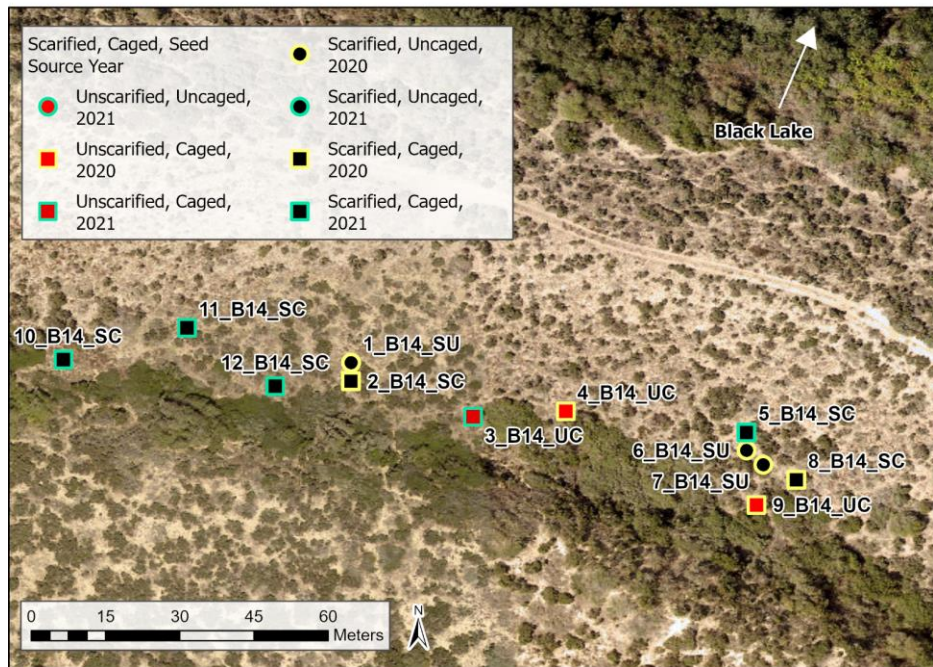


Figure 9a. 2021 & 2022 augmentation plots at BLEA 2019 swale (12 plots).

Nipomo Lupine BLEA-14 Augmentation Plots

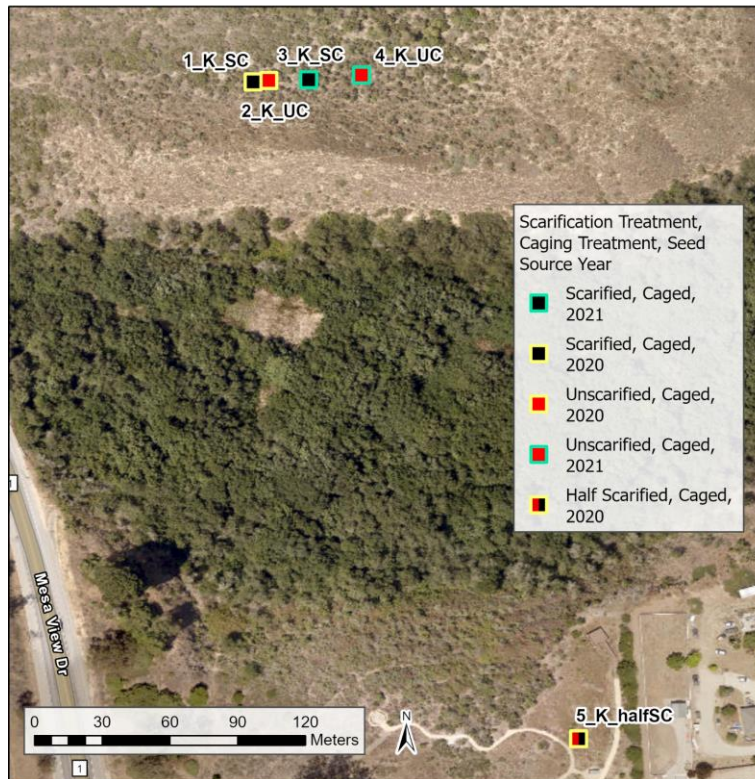


This represents the 10'x10' augmentation plots established in the swale south of Black Lake. Plots 1 through 9 were established in 2021, while plots 10 through 12 were established in 2022. The first number in the code is a unique value, the second portion of the code is B for BLEA and year that the swale was first monitored, the first of the 2 letter code either U or S represents if it is (S) Scarified or (U) Unscarified, and the last letter either U or C represents if it is (C) Caged or (U) Uncaged.

Mapped by Claire Wilhelm-Safian on 3/10/23.
Contact: cwilhelm-safian@ucsb.edu

Figure 9b. Augmentation Plots at BLEA 2014/15 swale (12 plots).

Nipomo Lupine KGJO Augmentation Plots

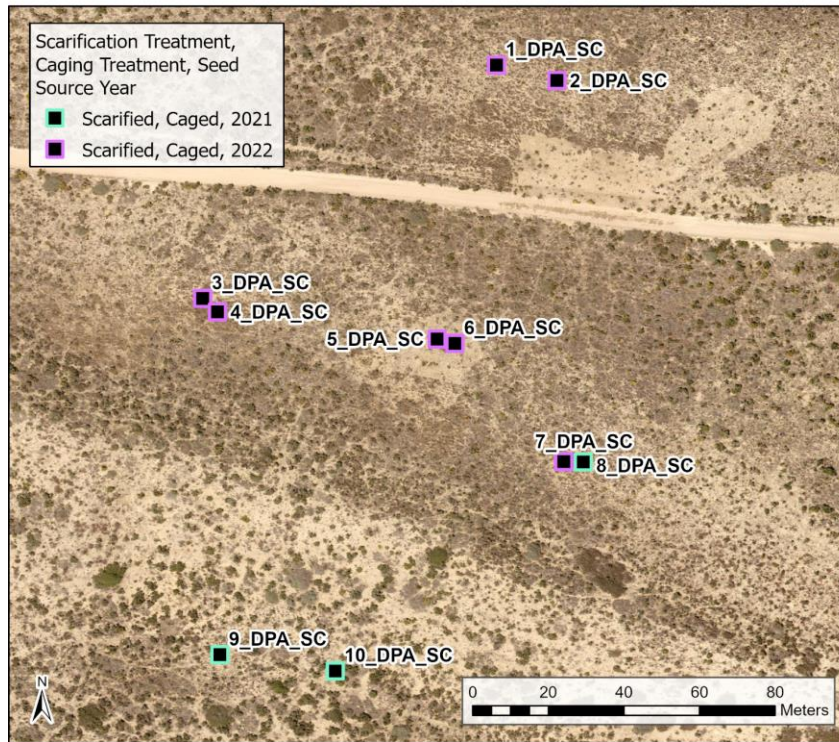


This represents the 10'x10' augmentation plots established at Kathleen Goddard Jones Overlook in 2021. The first number in the code is a unique value, the second portion of the code is B for BLEA and year that the swale was first monitored, the first of the 2 letter code either U or S represents if it is (S) Scarified or (U) Unscarified, and the last letter either U or C represents if it is (C) Caged or (U) Uncaged. Plot 5 is

Mapped by Claire Wilhelm-Safian on 3/10/23.
Contact: cwilhelm-safian@ucsb.edu

Figure 9c. Augmentation plots at KGJO swale (4 plots).

Nipomo Lupine DPA Plots



This map represents the 10'x10' augmentation plots established in the Dune Protected Area near the Phillips 66 Santa Maria Refinery. All plots at this site were seeded on 11/6/2022. For the plot IDs, the first number in the code is a unique value, the second portion of the code is DPA for Dune Protected Area, the first of the 2 letter code either U or S represents if it is (S) Scarified or (U) Unscarified, and the last letter either U or C represents if it is (C) Caged or (U) Uncaged. At this site, all plots were caged and scarified.

Mapped by Claire Wilhelm-Safian on 3/10/23.
Contact: cwillhelm-safian@ucsb.edu

Figure 9d. Augmentation plots at the Dune Protected Area (10 plots).

The augmentation plots at DPA were seeded on 11/2/2022 just before a heavy rain event (Figure 10). These seeds were bulked in our greenhouse from seed originally collected from BLEA and KGJO. Two new augmentation plots in the BLEA-14 swale were seeded in early December a few days after a rain event (11_B14_SC and 12_B14_SC), but seeding the other four new plots at BLEA was delayed due to a scheduled helicopter application of herbicide. The remaining four plots at BLEA were seeded on 1/12/23 during a moderate rain event that lasted several days.

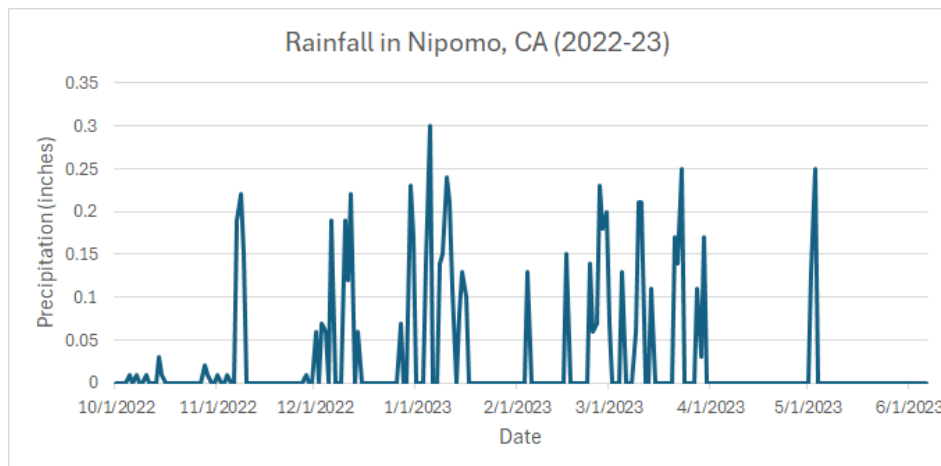


Figure 10. Line graph showing rainfall (inches) in 2022-23. There were consistently heavy rain events throughout the winter and early spring reaching up to 0.3 inches in a single day.

2023 Augmentation Plot Results

Consistent with findings from 2021-22, scarified seeds germinated at a higher rate (7.32%) compared to unscarified seeds (1.42%), though this was not found to be significant ($p = 0.4040$) (Figure 11). Seeds were scarified by individually dragging them across a piece of 200 grit sandpaper for approximately 4 inches in order to rub off the protective coating on the shell. The seeds produced in the previous year from the first generation of germinants did not undergo this artificial treatment; therefore, the effect of the scarification treatment is not reflected in the results of the following year. The degree to which seed is naturally scarified in situ is unknown.

Average percent germination from the estimated seed bank was also significantly higher in caged (6.88%) compared to uncaged (0%) plots (Figure 12). In the first year, uncaged plots had a relatively low germination rate of 1.5%. There was no germination whatsoever in uncaged plots in 2022-23, potentially due to seed herbivory over the course of the year since the initial seeding.

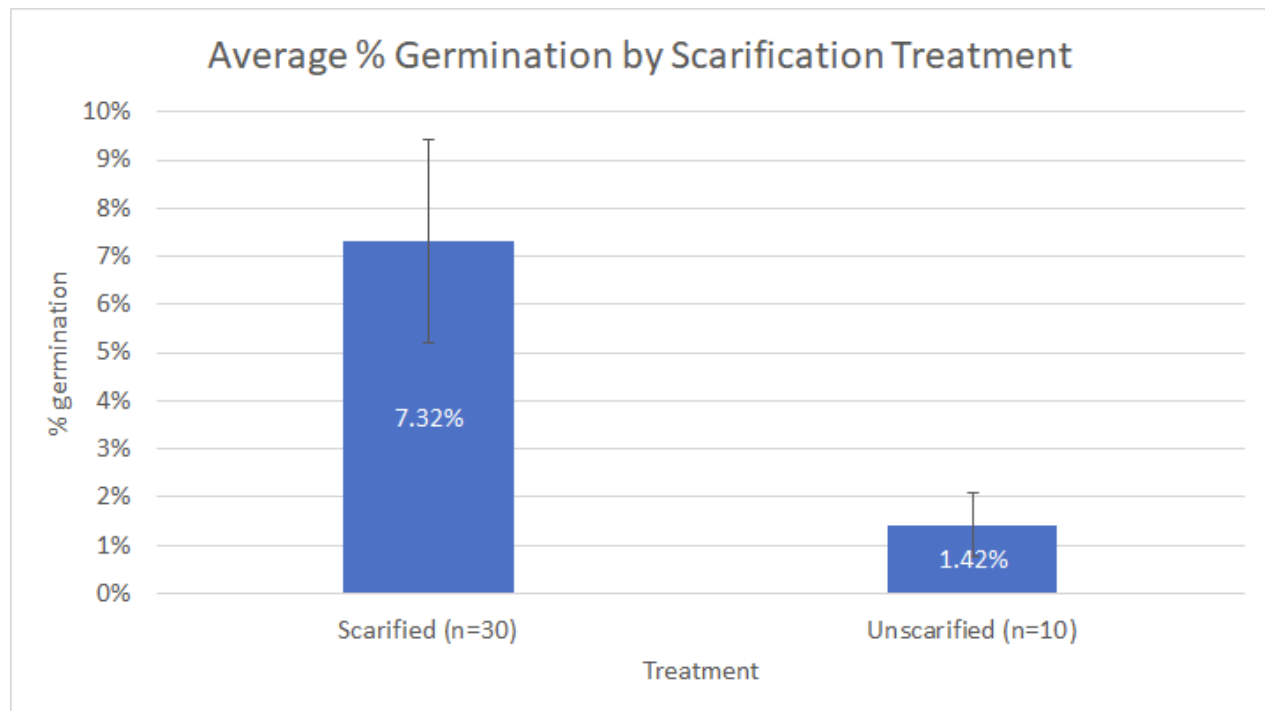


Figure 11. Column chart showing the average percent germination from scarified seed versus seed that did not receive the treatment. Error bars represent the standard error of each sample.

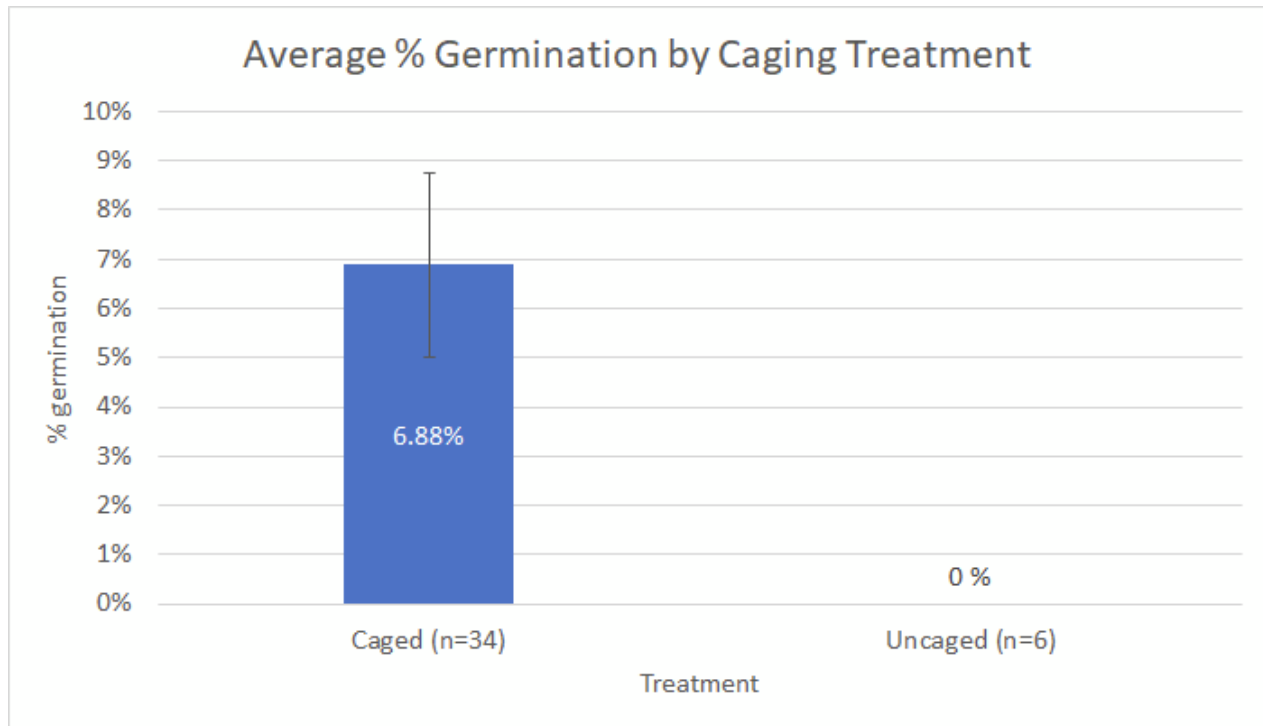


Figure 12. Column chart showing the average percent germination in caged plots versus uncaged plots. Error bars represent the standard error of each sample.

Overall, germination was the highest at DPA, which was expected due to the relative recency of adding seed to the plots (Figure 13). In our experience, plots have the most germination in the late fall of their first year post-seeding in the late fall, declining in the following years after seed has been exposed to potential seed predation. DPA’s 19.90% average germination rate in its first year is comparable to BLEA’s 22% in 2021-22. Now in its second year, post-seeding, BLEA’s average percent germination has dropped to 1.58% based on the estimated seed bank. No lupines germinated in the KGJO augmentation plots. This may be explained by the low germination at KGJO in 2021-22 (3.7%). None of the lupines of the first generation survived to reproductive adulthood, so the seedbank was not replenished after the initial seeding.

The augmentation plots at DPA and BLEA that were sown in the winter of 2022-23 with seed sourced in 2021 had a significantly lower germination rate (0.88%) compared to those sown with seed source in 2022 (24.06%) ($p = 0.0013$). We have had success germinating older seed in the past, but some unknown factor (possibly improper storage) led to premature seed expiration for the 2021 batch.

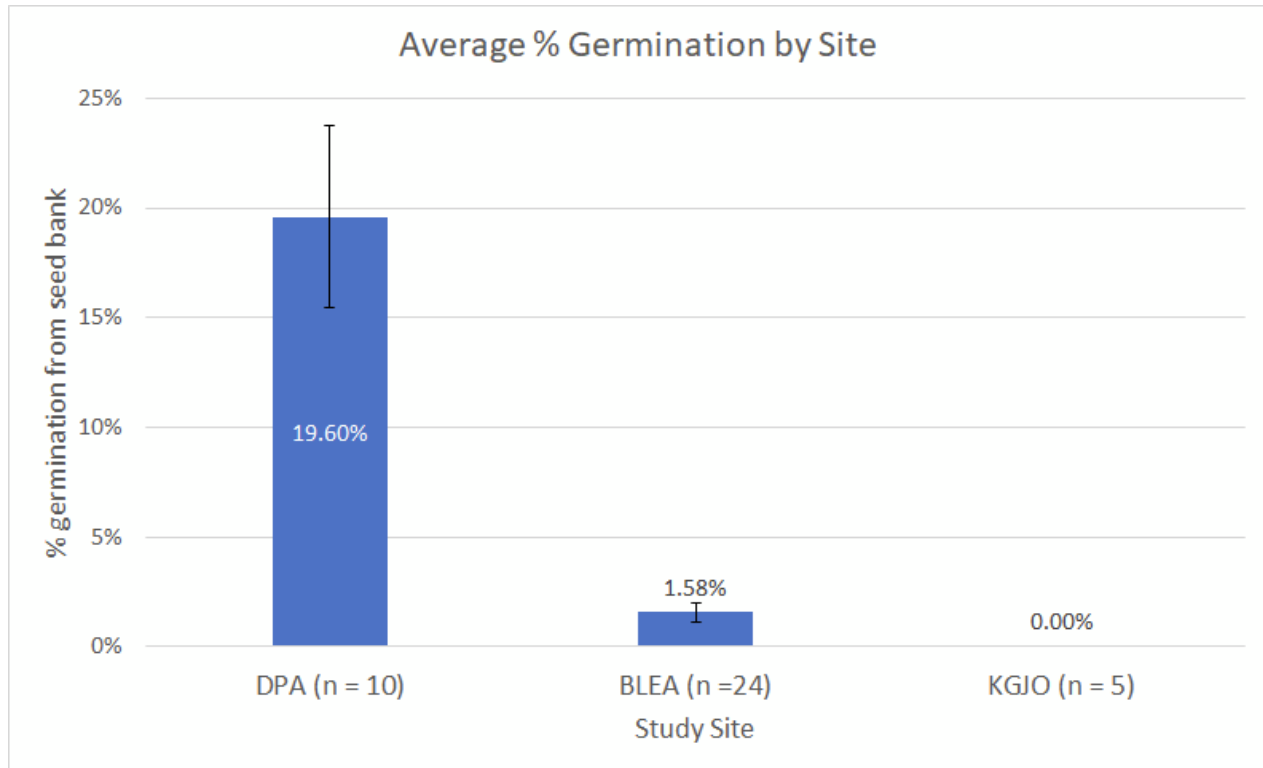


Figure 13. Column chart showing the average percent germination at each study site. Error bars represent the standard error of each sample.

Over half of the lupines in the DPA plots survived to set seed (58.59%), significantly more than those in the BLEA augmentation plots (32.12%) ($p = 0.0031$). In addition, lupines at DPA produced significantly more seeds per plot on average (8,817) than those at BLEA (735) ($p = 0.0052$), though the average seeds produced per plant was not significantly different between the two locations ($p = 0.4389$). Due to the large number of seedpods in some plots, the total was estimated from a random sample of five individuals per plot. The confidence interval for each estimated plot ranged between ± 4.97 and 19.56 seeds per plant ($\alpha = 0.05$). This was done for plots 3_B14_UC, 5_B14_SC, 8_B14_SC, 1_B19_SC, and 2_B19_SC at BLEA and plots 1 through 7 at DPA. The seedbank in each plot was estimated by adding 500 seeds sown, subtracting the seeds that germinated in the last two years, and adding the estimated seedpods in each generation multiplied by 2 (a conservative estimate of the number of seeds in each seedpod) (Figure 14). In total, there is an estimated seedbank of 2,337 seeds in KGJO augmentation plots, 31,873 in BLEA plots, and 92,193 in DPA plots. However, the seedbank estimates do not take into account seed predation by rodents and birds that have been documented consuming seeds using motion-sensored wildlife cameras.

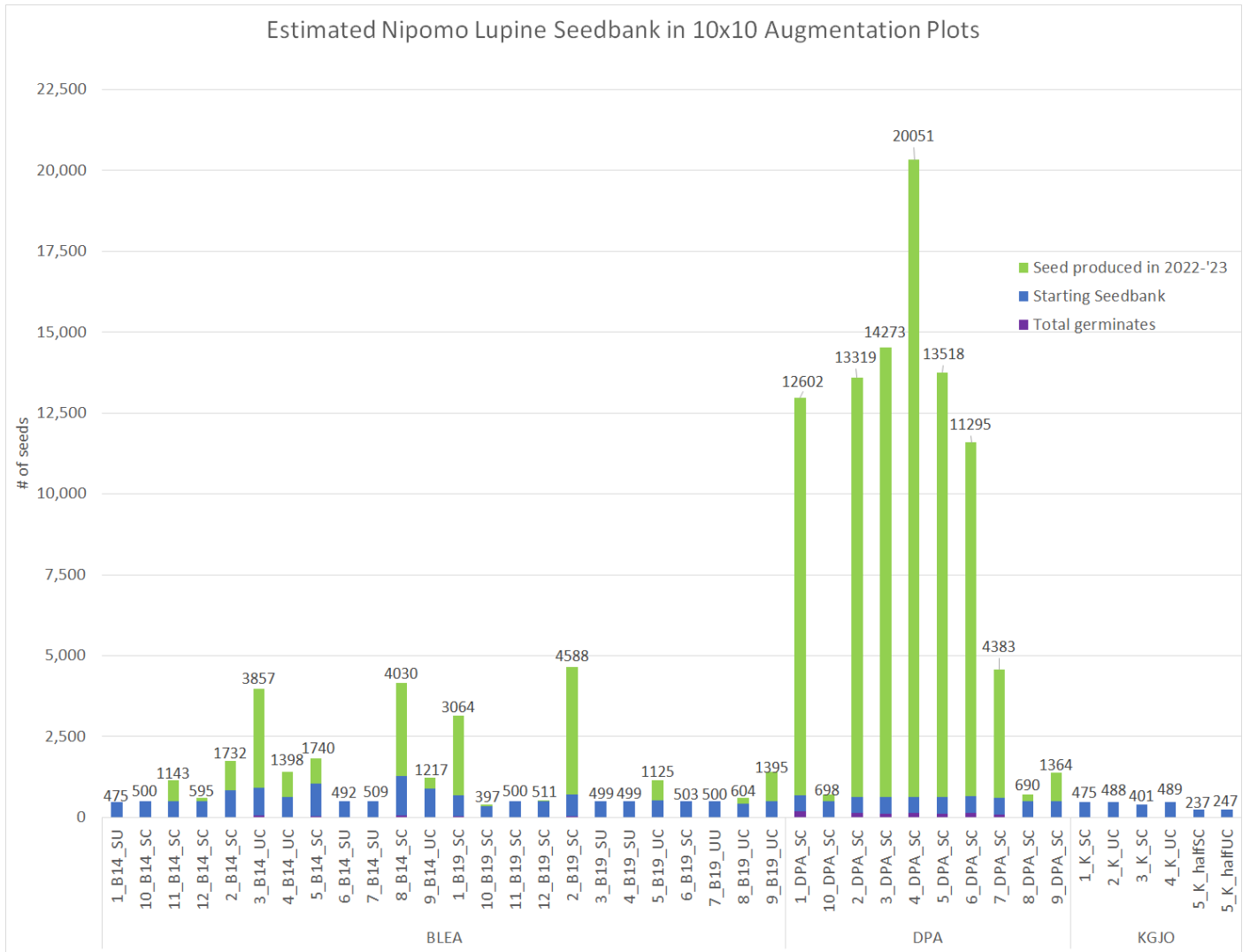


Figure 14. Column chart showing the estimated seedbank in each augmentation plot.

Updates on the BLEA 14/15 Trial

In 2014, the Cheadle Center set up an experimental seeding trial at BLEA designed to measure the effect of herbivory on seedling survival and population persistence. This experiment compared results from three caging treatments: an enclosed cage with a 0.25 in² mesh lid (small cage), an enclosed cage with a 2 x 4 in² mesh lid (large cage), and a control consisting of four rebar posts and no barriers. The plots were also characterized by microtopography (north-facing steep slopes, south-facing steep slopes, south-facing gentle slopes, no aspect ridge, and no aspect swale).

The winter of 22-23 represented the ninth year of this experiment. The rate of germination has significantly decreased over time ($p < 0.001$) (Figure 15a). In 2022-23, only two plots produced

any lupine, both small cages designed to exclude all herbivorous birds and mammals. Seven individuals survived to set seed (six in small cage 5, one in small cage 1). Seed production varied over the years, but was found to increase over time for plots with germinated individuals ($p = 0.023$), while decreasing over time when considering all plots ($p = 0.020$) (Figure 15b). This may indicate that fewer plots contain reproductive lupine, but those that do are producing more seeds over time (Figure 15c).

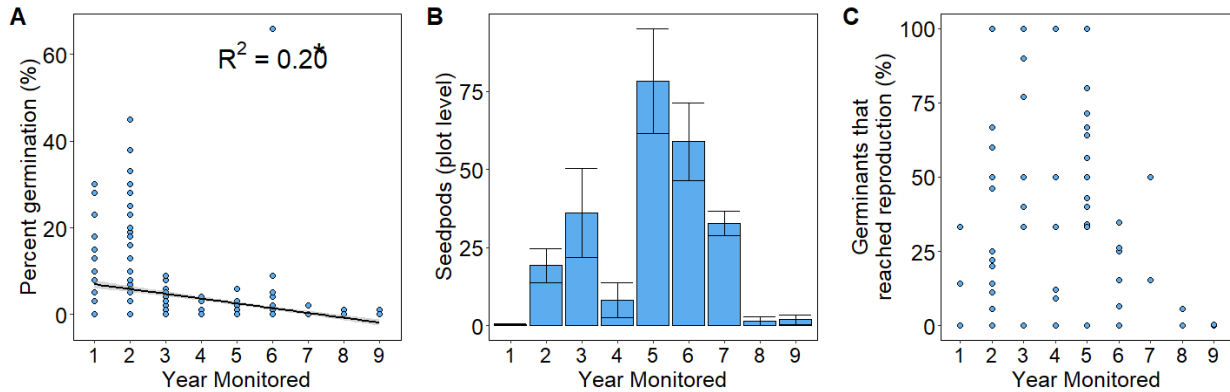


Figure 15. Charts showing the trends over time in percent germination, number of seedpods, and reproductive success in the BLEA14/15 experimental plots.

Initially, steep slopes seemed to be the preferred microtopography, but since Year 4, swale plots have had the most germination, with negligible germination in other plots since 2020. (Figure 16).

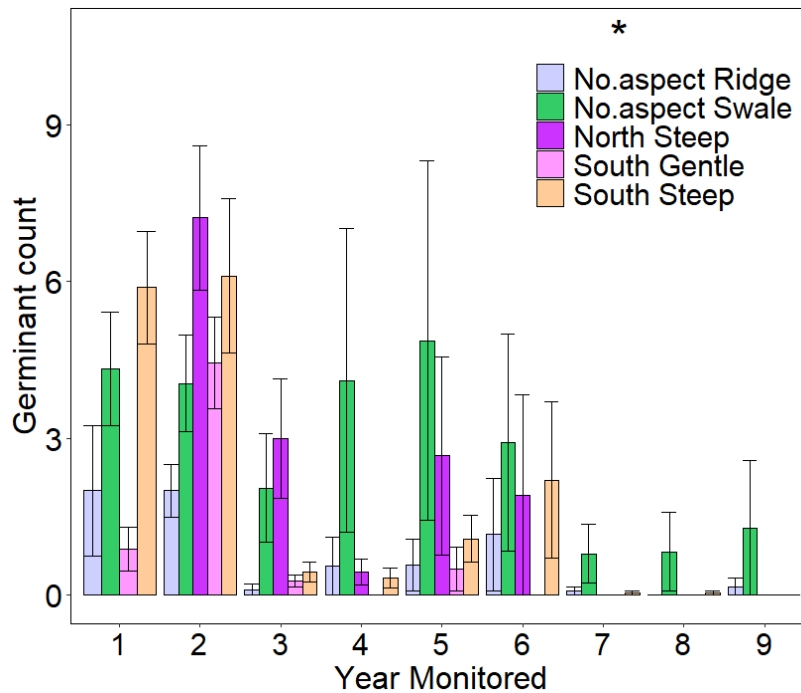


Figure 16. Column chart showing the total germination over time in BLEA 14/15 experimental plots grouped by microtopography.

Cal Trans Site

The lupine population in the Highway 1 right of way at the entrance to the Phillips 66 refinery is under the purview of Cal Trans, which manages the area through annual mowing in the summers (Figure 17). In 2019-2020 and 2020-21, the site was subdivided into 10 paired zones, which were either weeded or not weeded, to examine the impact of soil disturbance and competition with other vegetation. The population in those years were confined to just two of the ten plots, which happened to be weeded plots, so there was insufficient data to find any significant impact of weeding on germination. In both years, ~17 individuals were recorded. The weeding treatment was not continued in 2021-22, though it was monitored for seedlings twice, with an observed 7 germinants. In 2022-23 the site was monitored in mid-April and at the beginning of June. 51 individuals were observed in April, more than a seven-fold increase in population size from the previous year. In April, two-thirds of the population were flowering, and 11 individuals had started fruiting. By June, every lupine had reached reproductive maturity and produced seed. The annual mowing by Cal Trans seems to provide sufficient disturbance and openness for a small population of Nipomo lupine to subsist and even expand in wet years.



Figure 17. Photo of the Cal Trans right of way on April 10, 2023, with several flowering Nipomo lupine growing amidst clumps of *Ehrharta calycina*.

Seed Predation Assessment

In 2021-22, Mary Cadogan, an undergraduate student at UC Santa Barbara, conducted a study on the relationship between Nipomo lupine seed predation, distance from shrub vegetation, and caging treatment (Cadogan, 2023). Trays baited with lupine seeds were placed within the augmentation plots at KGJO and BLEA, as well as outside of cages both near and far from shrubs. The trays each contained twenty seeds, the remainder of which were counted four months later to calculate the rate of seed predation. Each bait station was also equipped with a motion-activated wildlife camera to record footage of seed predation or herbivory. Cadogan's initial study found that caged plots lost the most seeds, followed by uncaged bait stations near vegetation, and lastly uncaged stations far from vegetation. However, video footage in the caged plots showed the least amount of herbivory, though some rodents and birds were recorded. Footage of uncaged stations near vegetation showed the most evidence of seed predation, while footage of uncaged stations far from vegetation showed the most herbivory of plant foliage. Due to the infrequency of data collection visits to the bait stations and the possibility that seeds were lost from the trays due to factors other than predation (i.e. blown out by wind, scoured out by rain etc.), the data was deemed insufficient to fully address the hypothesis.

In 2022-23, another student, Calen Campos, continued the seed predation study at KGJO and DPA, with a focus on proximity to veldt grass specifically. Does veldt grass provide greater habitat for rodents, with an associated increase in seed predation adjacent to dense stands of veldt? Initially, eight bait stations and camera traps were placed at KGJO adjacent or within dense veldt grass, near (within 1m) of veldt grass, and far (> 2m) from veldt grass. Wind and rain scour were confirmed to contribute to seed loss from the bait stations. However, short deployments of two to five days did not provide much evidence of seed predation; a deployment length of approximately 20+ days was settled upon to allow for human scents and disturbance to diminish. These lessons informed the final experimental design at DPA: a total of eight seed stations were placed either within dense veldt grass or greater than 2 meters from veldt grass. Additionally, the bait stations were placed within or outside of caged augmentation plots, with three paired camera traps in each treatment.

During short deployments, there was no significant difference in seed loss between stations adjacent to veldt and far from veldt. However, more seeds were lost from stations adjacent to veldt grass during long deployments (Figure 18). Due to limitations around herbicide management and ESA permitting, the bait stations could not be placed outside of a 15 meter buffer around the established augmentation plots which had been placed in areas where Nipomo lupine had been documented historically and where no aerial spraying of clethodim was permitted already. However, the home ranges of granivorous rodents average 200 feet (~60 meters); designating stations further than a mere 2 meters from veldt as "far," may be insufficient to fully investigate the relationship between seed predation and veldt grass in terms of whether stands of veldt grass support higher densities of granivorous rodents such as kangaroo rats.

The stronger relationship was between seed loss and caging treatment, with ~70% seed loss in uncaged bait stations and ~15% in caged plots ($p > 0.0001$) (Figure 19). The camera traps recorded footage of mice, kangaroo rats, birds, and other wildlife foraging within the bait trays. Although caged plots did not entirely exclude rodents, wildlife capture rates were significantly higher in uncaged plots (6.25/day) than in caged locations (0.09/day). Further research is needed to examine the role of veldt grass, but the study strongly indicates that caging significantly decreases Nipmo lupine seed predation. This study is discussed in more depth in Campos's paper, soon to be published on the Cheadle Center eScholarship website.

Further Management Recommendations

Seed predation and herbivory of young individuals is a major factor of Nipomo lupine success, with caged plots conferring a higher rate of germination and survival to reproductive maturity. Even in ideal wet conditions, such as the 2022-23 year, winter germination following highly successful seed set the previous spring in any given plot could be quite low, suggesting major loss to seed predation during the summer and fall. However, caging to exclude rodents and birds is feasible only in limited situations due to staff availability and supply costs, especially during boom years. For instance, in 2023, only 55% of the lupines at DPA were caged (CDFW, 2023). CA State Parks have started implementing a strategy of protecting successful lupines with fully enclosed inverted gopher cages in the summer and leaving those cages in place until the following winter, ideally to prevent seed predation by rodents and birds during the intergenerational period of summer and fall.

Our studies reveal that Nipomo lupine has a preference for swales with no aspect. Although the competition/facilitation experiment at KGJO and the weeding experiment at the Cal Trans site did not establish a statistically significant relationship between weeding and lupine germination, cleared plots did trend toward higher lupine germination. We recommend removal of veldt grass specifically; the monoculture of dense stands of this perennial bunch grass has drastically changed the open sand dune habitat of the area. Given its ubiquity, its primary and secondary effects on the ecosystem are likely underappreciated. While direct competition with *L. nipomensis* can be relatively easily observed, indirect effects are more cryptic. How these grasses affect sand movement across landscapes and therefore seed scarification, distribution, burying or exposure is unknown.

As discussed earlier, the role of veldt grass in sustaining populations of seed predating rodents and birds requires further research. By altering both cover and plant diversity, native vertebrates may be occurring at different densities than natural background levels. Further, granivorous vertebrates may be “sick and tired” of eating veldt grass, or of not eating their “normal” plant foods; therefore helping to push rare plants into states of greater scarcity or extirpation by selecting their seedlings or seeds for the sake of having a diverse diet—the same diet they evolved

with. Future studies could include scat eDNA analysis or isotopic studies of the fauna to identify their diets. Museum specimens collected from periods before veldt was so pervasive could provide information on what they were consuming historically. In addition, consideration could be given to conducting much larger-scale experiments to avoid edge effects where bird or rodent densities and/or behaviors could be studied without inputs from modern population or behavior patterns.

Additionally, veldt grass may be having an allelopathic impact on Nipomo lupine. The Cheadle Center conducted a simple greenhouse experiment demonstrating an allelopathic effect of veldt grass on miniature lupine (*Lupinus bicolor*). *L. bicolor* seeds irrigated with DI water had 99% germination, whereas the seed watered with veldt grass leachate had almost no germination (Couvillion, 2023). We recommend a replication of this study using *L. nipomensis* seed.

Veldt grass removal via herbicide and hand-pulling has been a key management strategy at BLEA and DPA. Thanks to these efforts, there has been a 40% decrease in dense veldt cover at DPA between 2017 and 2022 (Alvarez, 2022). This reduction coincides with a steady increase in the Nipomo lupine population according to State Parks surveys (CDFW, 2023). Aerial spraying of clethodim, a grass-specific herbicide, has been the primary method of control. In 2020, the Cheadle Center conducted a greenhouse experiment which found no impact of clethodim on Nipomo lupine germination, vigor, or seed production (Chapman et al., 2020).

Due to the stochastic population dynamics of *L. nipomensis* we recommend protecting and restoring as much of the home range as possible. The Phillips 66 Santa Maria refinery ceased operations in January of 2023; the removal of the facility is currently in the planning and environmental review stage, with a draft EIR to be released in March of 2024. The remediation of the site may provide opportunities for Nipomo lupine restoration.

2023 was the final year of the USFWS Section 6 grant award period for the Cheadle Center's research and restoration of Nipomo lupine. No monitoring data was collected by the Cheadle Center in the winter of 2023-24. We remain a consulting member of the Nipomo lupine working group along with the Land Conservancy of San Luis Obispo and California State Parks, which have incorporated our experimental and augmentation plots into their own monitoring protocols. They have started to remove cages that have not produced Nipomo lupine seedlings in the past few years, or at all, in order to concentrate their effort and establish an appropriate herbicide treatment buffer.

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