Introduction of the threatened Kincaid's Lupine to the Starck Restoration Site

Final Report
November 2005

Thomas N. Kaye, Karin Rohland and Steven Gisler
Institute for Applied Ecology

Prepared for
Northwest Habitat Institute
and U.S. Fish and Wildlife Service
by
Institute for Applied Ecology, Corvallis, Oregon

PREFACE

This report is the result of contract work by the Institute for Applied Ecology (IAE) to support habitat restoration and endangered species recovery. IAE is a non-profit organization dedicated to natural resource conservation, research, and education. Our aim is to provide a service to public and private agencies and individuals by developing and communicating information on ecosystems, species, and effective management strategies and by conducting research, monitoring, and experiments. IAE offers educational opportunities through 3-4 month internships.

Questions regarding this report or IAE should be directed to:

Thomas N. Kaye
Institute for Applied Ecology
563 SW Jefferson Ave.
Corvallis, OR 97333
phone: 541-753-3099
fax: 541-753-3098
email: kayet@peak.org

The Institute for Applied Ecology would like to acknowledge the contributions and cooperation provided by Clem and Barbara Starck (landowners), U.S. Fish and Wildlife Service, Northwest Habitat Institute, Heritage Seedlings, and IAE staff and interns: Matthew Blakeley-Smith, Robert Castlen, Luke Clardy, John Grotefend, Marin Palmer, Karin Rohland, and Carla Wise.

Cover Photo: Kincaid's lupine seedling growing within a seed sowing plot located at the Starck restoration site (photo by Thomas N. Kaye).

EXECUTIVE SUMMARY

- Eighty-two Kincaid's lupine plants are established within six patches in two restoration areas on private land near Dallas, Oregon owned by Clem and Barbara Starck. Lupine was introduced to the site via seeding and planting of containerized stock in 3 phases beginning in 2002 and ending in 2005.

- A total of 40 Kincaid's lupine plants were established via seed on the Starck Property as of May, 2005 . This number represents 2.6% of the 1550 seeds planted on site since 2002. The majority of these plants (33) were present in Patch 1 in the Upper Field and the remaining seeded plants were in Patches 2 and 3 in the Lower Field. First year establishment rates from seed were 5.5% for the 2002 seeding and 14.3% for the 2003 seeding.

- A total of 42 transplanted Kincaid's lupine plants were established on the Starck property as of May, 2005. This number represents 10% of the 395 container stock planted on the site. Twenty-eight of these plants were in Patch 6 that was planted in 2005 in the Upper field of the property. The remaining 14 plants were scattered throughout Patches 1-5 in both the Upper and Lower fields. The first year survival rate was 2.9% for the 2004 planting.

- Scarification of seeds prior to planting had a positive impact on first year establishment (7.5% of scarified seeds resulted in a seedling and 3.1% of nonscarified seeds resulted in a seedling), but made little difference in the long term establishment of plants (3% from scarified seeds and 2.4% from non-scarified seeds after 3 years).

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Project description

The objective of this project is to establish and monitor Kincaid's lupine plants within a 20-acre oak savanna restoration site located on the Starck property near the city of Dallas in Polk County, Oregon.

Background information

Kincaid's lupine (*Lupinus sulphureus* ssp. *kincaidii*) (Figure 1) is a rare member of the legume family listed by the State of Oregon and the U.S. Fish and Wildlife Service as a threatened species. Fender's blue butterfly (*Icaricia icarioides fenderi*), listed as an endangered species, depends upon the lupine as a larval host plant. As a result of this unique relationship, conservation of the lupine not only benefits the plant itself but the butterfly as well. Kincaid's lupine occurs in native prairies, oak savannas, and forest meadows in southwestern Oregon (Douglas Co.), the Willamette Valley, and southwestern Washington. The rarity and threatened status of Kincaid's lupine are attributable to habitat loss caused by invasive weeds, fire suppression, and urban/agricultural development.

Figure 1. Kincaid's lupine *(Lupinus sulphureus* ssp. *kincaidii*) is a threatened species and also serves as the host plant for the endangered Fender's blue butterfly in the Willamette Valley.

Historically, the 20-acre restoration site (and target site for Kincaid's lupine establishment) at the Starck property was used as a cultivated hay field. As a result, the overall species diversity at the site is low and dominated by non-native grasses and various herbaceous weeds. However, habitat restoration activities are now being conducted to reduce the cover of exotic species and re-establish a native savanna community. If the project is successful, Kincaid's lupine will be a component of this restored community.

METHODS

Two general methods were utilized to introduce Kincaid's lupine to the Starck property: sowing lupine seeds directly onto the soil and planting containerized stock. The Institute for Applied Ecology (IAE) has successfully created and enhanced Kincaid's lupine populations at other Willamette Valley locations using both introduction methods. Five areas (referred to here as "patches") were selected as introduction sites at the Starck property. Patches 1, 5, and 6 are located in the Upper Field, while Patches 2, 3 and 4 are located in the Lower Field (Figure 4). As described below, these patches are comprised of multiple plots planted with lupine seeds and/or containerized seedlings. The lupine introductions were performed in two phases: Phase 1 was carried out in winter of 2002 and Phase 2 was performed in winter of 2003 and spring of 2004, and Phase 3 was conducted in the spring of 2005. Final monitoring was conducted in 2005.

Introduction using seeds

Seed sowing was performed twice (in two phases) within Patches 1-3 at the Upper and Lower Fields of the Starck property. Phase 1 seed sowing was performed on December 19, 2002, and Phase 2 was performed one year later on December 22, 2003.

During Phase 1, a total of 750 seeds were sown into 15 plots. Each plot was 1 x 2 m in size and was divided into two 1 x 1 m halves, marked with wooden stakes and yellow flags (Figures 5-7). Each 1 x 1 m half-plot received 25 seeds and was randomly assigned a scarified or non-scarified seed pre-treatment (scarified seeds had their seed coats scraped, a procedure known to promote seed germination in Kincaid's lupine and other legume species). Seed sources used for Phase 1 included Kincaid's lupine populations at LaBarre Road and West Hills Road, located on county and private lands in Benton County. Seeds were collected from the two sites between July 18-22, 2002, under authority of IAE's state- and county-issued collection permits. Table 1, in the Results section of this report, indicates the seed source and treatment applied to each 1 x 2 m seed sowing plot.

Figure 2. Photograph showing seed sowing plots at the Starck restoration site in 2003. Sod was removed prior to sowing to reduce seedling competition with weeds.

During Phase 2, a total of 800 seeds were sown into 16 plots. All seeds were non-scarified and were sown into 1 x 1 m square plots (Figures 5-7). All plots were scraped 2-4 cm deep prior to seed sowing to remove sod and weeds (Figure 2), and were mulched with a shallow (<1cm) layer of peat moss after seeding to increase soil moisture retention. Seed sources for Phase 2 included

the West Hills Road population in Benton County, and the Muddy Valley and Gopher Valley Road populations in Yamhill County. Seeds from the Muddy Valley population were obtained from the Oregon Zoo and the remaining seeds were collected between July 22-25, 2003, under IAE's state- and county-issued collection permits. Table 1, in the Results section of this report, outlines the seed source applied to each 1 x 1 m seed sowing plot. Seedling establishment in all sowing plots was monitored on April 16, 2004 and May 12, 2005.

Introduction using containerized stock

Transplanting of containerized seedlings was performed three times (in three phases) within all six patches at the Upper and Lower Fields of the Starck property. Phase 1 of transplanting was performed on April 16, 2003, and Phase 2 was performed exactly one year later on April 16, 2004. Phase 3 was conducted on April 18, 2005.

During Phase 1, 300 lupine seeds were put into cultivation. Of these, 282 germinated, but due to high mortality during the first 3 months of growth only 125 seedlings were ultimately available for transplanting to the Starck property. This rate of mortality is commonly encountered during cultivation of Kincaid's lupine due to its high susceptibility to fungal "damping off" disease in the greenhouse. Of the 125 surviving seedlings, 45 were planted at the Upper Field in Patch 1 (Figure 5), 40 were planted at the Lower Field in Patch 2 (Figure 6), and the remaining 40 seedlings were planted in Patch 3 (Figure 7). A total of 67 seedlings originated from LaBarre Road seed stock and 58 came from West Hills Road seeds. These plants were placed along a grid to facilitate their relocation for monitoring growth and survivorship over time (Figures 5-7).

During Phase 2, 704 lupine seeds were put into cultivation. Of these, 680 germinated, but once again the seedlings experienced high mortality, this time partially attributable to an invasion of hungry birds into the greenhouse (the birds ate the seedlings' cotyledons). As a result, 210 seedlings were available for transplanting to the Starck property. Of these, 120 were planted into 4 equal rows within Patch 4 and 90 were planted into 3 equal rows within Patch 5 (see Figure 4 for patch locations). A total of 100 seedlings originated from West Hills Road seed stock, 55 seedlings originated from Deer Creek Park seed stock (obtained from the Oregon Zoo), and 55 seedlings came from Gopher Valley seeds. Seedlings were planted at 1 m spacings in 30 m long, parallel transect rows (Figure 3). Row ends were marked with wooden stakes. This planting design allowed for relocation of plants for monitoring growth and survivorship over time.

Figure 3. Photograph showing Kincaid's lupine transplanting at the Starck restoration site.

In Phase 3, a total of 60 transplants grown from seed

gathered at the Lupine Meadows Kincaid's lupine population in Benton County were planted in Patch 6 in the Upper Field of the Starck property. Half of these plants (30) were inoculated with native soil from the Lupine Meadows site in order to gain the benefit of nitrogen-fixing *Rhizobium* bacteria and/ or mycorrhizal fungi. The lupine transplants were planted at 1 m spacings in 30 m transects. Inoculated or uninoculated plants were placed alternately along the two transects. No *Rhizobium* nodules were noticed at the time of planting.

All transplants were monitored on May 12, 2005.

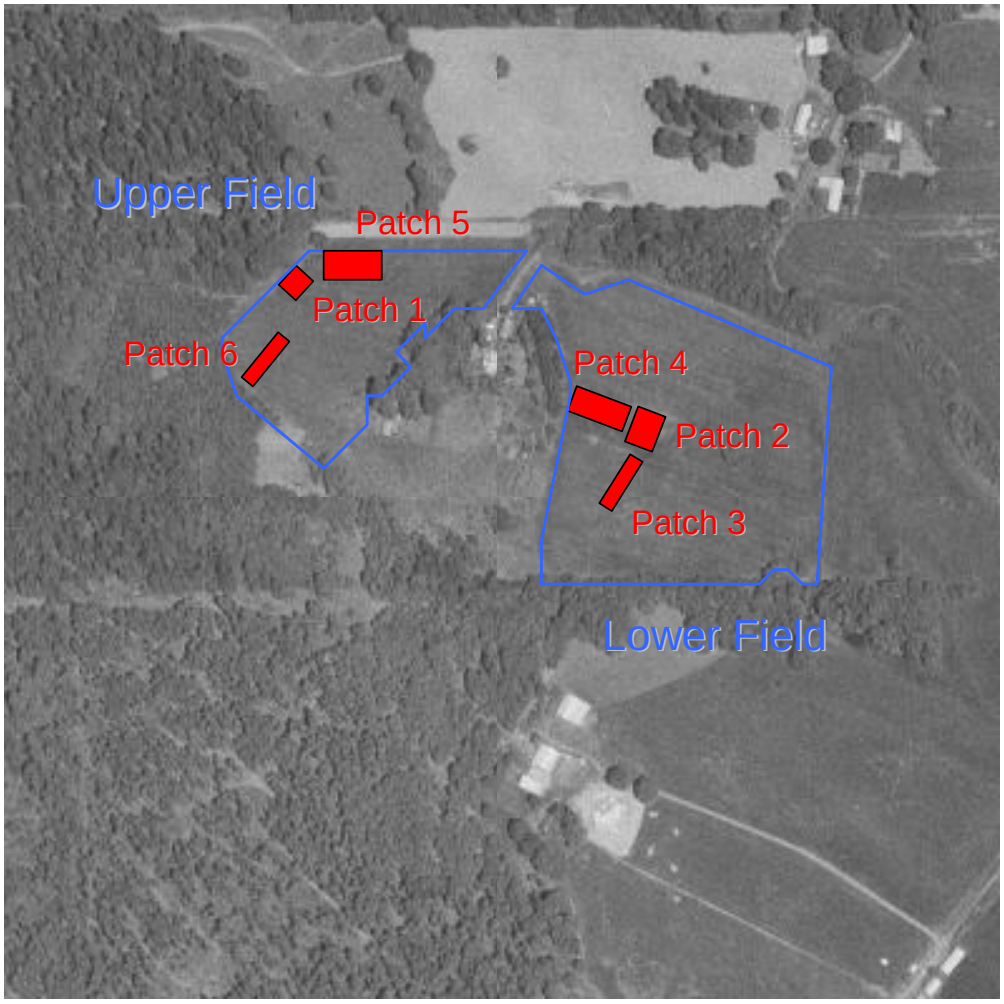
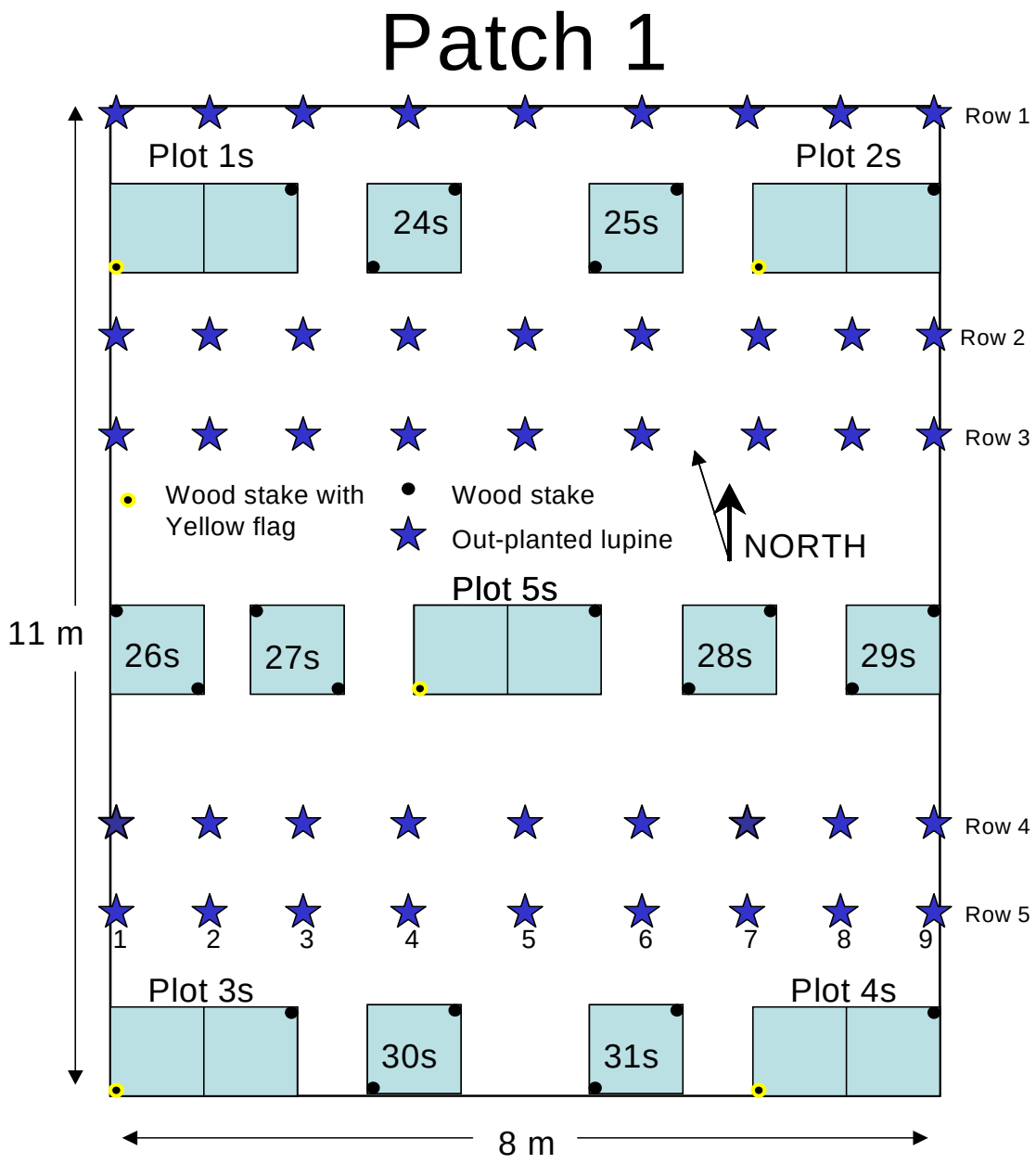


Figure 4. Aerial photograph (1994) showing Starck property savanna restoration site and the 6 Kincaid's lupine patches within the Lower and Upper Fields.



(Note: narrow arrow indicates 7.6 m at 348 degrees to metal fence post. Patch 1 is in upper end of Upper Field, near a large oak, near green metal fence post).

Figure 5. Kincaid's lupine seeding and planting layout in Patch 1 in the Upper Field of the Starck restoration site. Seeding plots established in Phase 1 measure 1 x 2 m, whereas those from Phase 2 measure 1 x 1 m (see text for explanation). Individual plot corners are marked by wooden stakes, and all plots are located within a 8 x 11 m patch. Phase 1 seedlings were planted at 1 m spacing within 5 parallel rows. Patch 1 is located 7.6 m at 168 degrees from a metal reference post

Patch 2

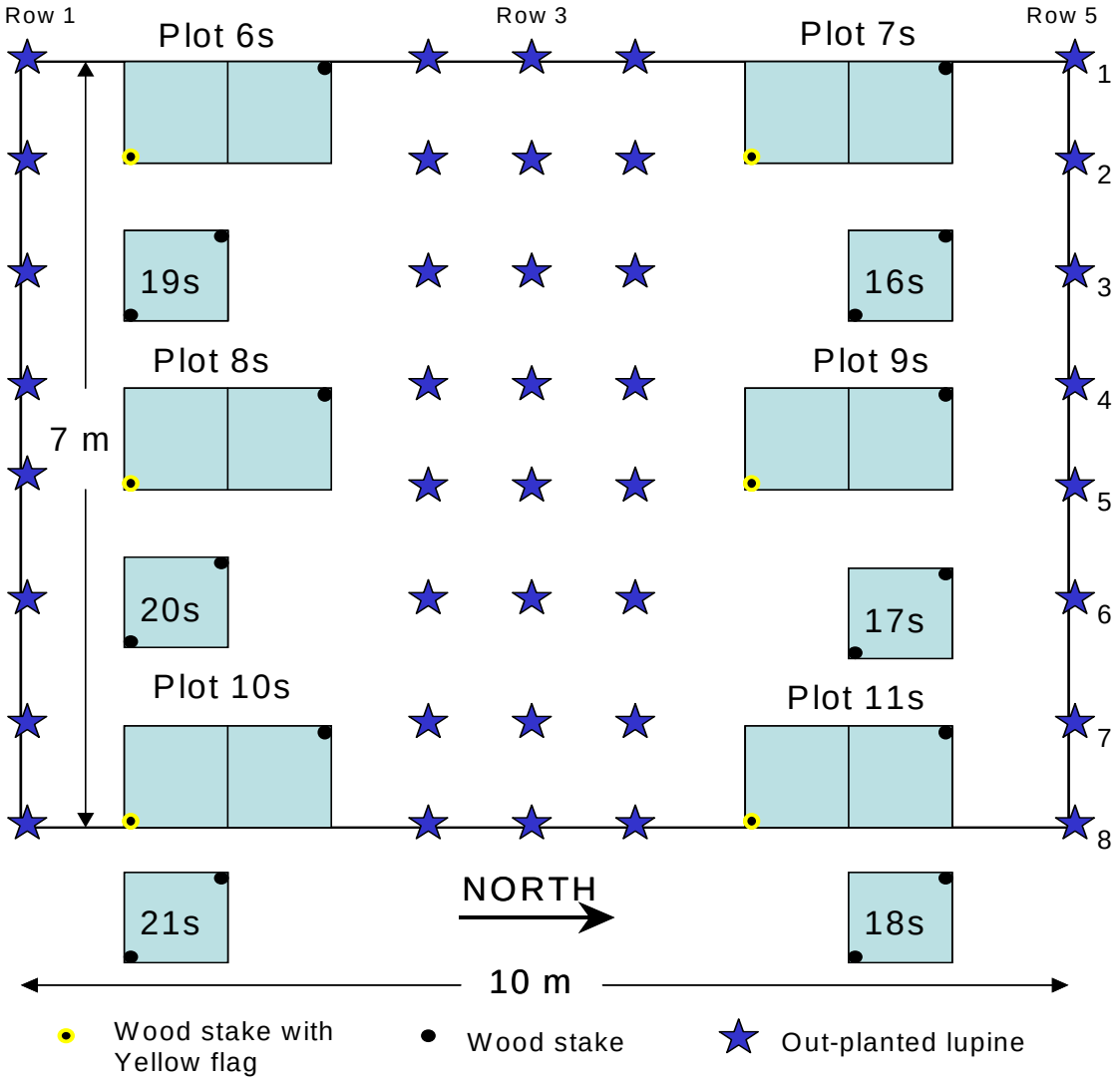


Figure 6. Kincaid's lupine seeding and planting layout in Patch 2 in the Lower Field of the Starck restoration site. Seeding plots established in Phase 1 measure 1 x 2 m, whereas those from Phase 2 measure 1 x 1 m (see text for explanation). Individual plot corners are marked by wooden stakes, and all plots are located within a 7 x 10 m patch. Phase 1 seedlings were planted at 1 m spacing within 5 parallel rows.

Patch 3

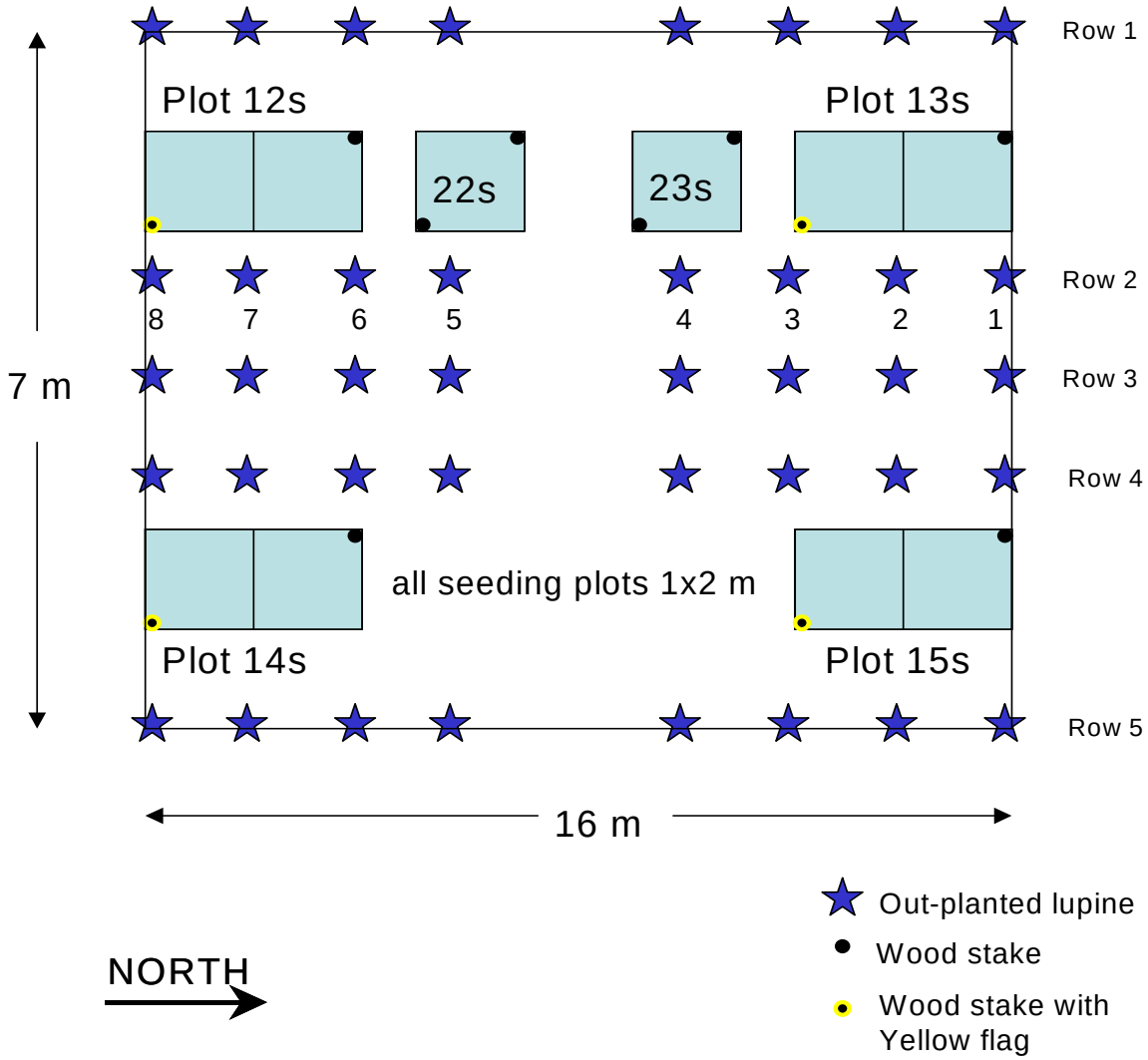


Figure 7. Kincaid's lupine seeding and planting layout in Patch 3 in the Lower Field of the Starck restoration site. Seeding plots established in Phase 1 measure 1 x 2 m, whereas those from Phase 2 measure 1 x 1 m (see text for explanation). Individual plot corners are marked by wooden stakes, and all plots are located within a 7 x 16 m patch. Phase 1 seedlings were planted at 1 m spacing within 5 parallel rows. No seeding or planting occurred in the draw which runs east to west through the center of the patch.

RESULTS

Introduction using seeds

Since 2002, a total of 1,550 Kincaid's lupine seeds have been sown at the Starck restoration site. Monitoring performed in 2005 showed recruitment of 40 Kincaid's lupine seedlings within 17 of the 46 sowing plots, representing 2.6 percent of the total seeds sown (see Table 2 for seedling data within each plot). The 40 plants had an average of 6.1 leaves per plant. Fifteen of the seedlings were survivors from sowing in 2002 (Phase 1 of the project), and the remaining 25 were located in sowing plots established in 2003 (Phase 2 of the project). The spatial distribution of seedling recruitment was as follows: Patch 1 contained 33 seedlings, Patch 2 contained 3 seedlings, and Patch 3 contained 4 seedlings (Table 1). The number of seedlings recruited from the different seed source populations was as follows: LaBarre Road yielded 5 seedlings (5.2% recruitment), West Hills Road yielded 19 seedlings (2% recruitment), Gopher Valley produced 13 seedlings (6.5% recruitment) and 3 seedlings (3% recruitment) emerged from Muddy Valley seed stock. First year recruitment was 5.5% in Phase 1 and 14.3% in Phase 2. Seeds were mulched with peat moss in Phase 2 to increase soil moisture retention. Comparisons of seedling recruitment from scarified and non-scarified seeds during Phase 1 showed a significant difference in one year establishment rates (p-value of 0.045 from a Mann Whitney U test for difference in medians). There was an average of 7.5% (SE = 2.3) establishment of scarified seeds, and 3.1% (SE = 2.1) establishment of nonscarified seeds. However, after 3 years there was little difference between the two treatments (3% versus 2.4% recruitment, respectively).

Table 1. Summary of established and surviving seedlings (SE) observed in 2003, 2004 and 2005.

Seeding characteristic	2003	2004	2005
2002 planting (%)	41 (5.5)	16 (2.1)	15 (2)
2003 planting (%)	NA	114 (14.3)	25 (3.1)
Patch 1	27	85	33
Patch 2	7	26	3
Patch 3	7	19	4
LaBarre	13	5	5
West Hills	28	79	19
Muddy Valley	0	10	3
Gopher Valley	0	36	13
scarified (%)	30 (7.5)	9 (2.3)	12 (3)
nonscarified (%)	11 (3.1)	121 (10.5)	28 (2.4)
total seedlings (% of total)	41 (5.5)	130 (8.4)	40 (2.6)

# of plots w/ seedlings	13	24	17

Table 2. Kincaid's lupine establishment, seed source, and year of seeding within seed sowing plots at the Starck restoration site in 2004 and 2005. As indicated below, plots established in 2002 were split into two 1 x 1 m halves, with one half randomly assigned a seed scarification treatment (see text for treatment explanation). All plots received 50 seeds each (25 seeds per half-plot in Phase 1).

Patch	Plot	Seed source population	Year of seeding	# surviving seedlings (April, 2004)	# surviving seedlings (May, 2005)
1	1	LaBarre	2002	scarified: 2	3
				non-scarified: 0	0
1	2	West Hills	2002	scarified: 1	1
				non-scarified: 0	0
1	3	West Hills	2002	scarified: 0	1
				non-scarified: 3	1
1	4	West Hills	2002	scarified: 1	0
				non-scarified: 0	0
1	5	LaBarre	2002	scarified: 0	2
				non-scarified: 3	0
1	24	West Hills	2003	11	2
1	25	West Hills	2003	3	1
1	26	Gopher Valley	2003	9	4
1	27	Gopher Valley	2003	20	8
1	28	Muddy Valley	2003	10	3
1	29	West Hills	2003	12	5
1	30	Gopher Valley	2003	1	1
1	31	West Hills	2003	9	1
2	6	West Hills	2002	scarified: 2	2
				non-scarified: 0	0

Patch	Plot	Source population for seeds	Year of seeding	# surviving seedlings (April, 2004)	# surviving seedlings (May, 2005)
2	7	LaBarre	2002	scarified: 0	0
				non-scarified: 0	0
2	8	West Hills	2002	scarified: 0	0
				non-scarified: 0	0
2	9	West Hills	2002	scarified: 1	0
				non-scarified: 0	1
2	10	West Hills	2002	scarified: 0	0
				non-scarified: 0	0
2	11	LaBarre	2002	scarified: 0	0
				non-scarified: 0	0
2	16	Gopher Valley	2003	1	0
2	17	West Hills	2003	9	0
2	18	West Hills	2003	4	0
2	19	West Hills	2003	4	0
2	20	Muddy Valley	2003	0	0
2	21	Gopher Valley	2003	5	0
3	12	West Hills	2002	scarified: 2	2
				non-scarified: 0	0
3	13	West Hills	2002	scarified: 0	0
				non-scarified: 0	0
3	14	West Hills	2002	scarified: 1	0
				non-scarified: 0	2
3	15	LaBarre	2002	0	0
3	22	West Hills	2003	8	0
3	23	West Hills	2003	8	0
				Total: 130	Total: 40

Introduction using containerized stock

Over the last three years, 395 containerized Kincaid's lupines have been cultivated and planted in all 6 patches at the Starck restoration site. A total of 42 (10.6 %) of these plants with an average of 4.7 leaves per plant were surviving on the Starck property on May 12, 2005. Patch 6 contained 28 of these plants and the remaining 14 were distributed throughout Patches 1-5. Exclude the Patch 6 seedlings which were transplanted less than one month prior to the final monitoring date, the survival rate falls to 4.2 %. A total of 16 (53.3 %) un-inoculated seedlings survived this brief interval and 12 (40 %) of the inoculated plants survived, suggesting little or no effect of inoculation with native soil at this site. First year survival of transplants from 2004 to 2005 was 2.9%.

Table 3. Summary of Kincaid's lupine recruitment from containerized stock at the Starck restoration site in 2005.

Year of outplanting	Seed source	Inoculated	Number planted	Number surviving May 12, 2005
2003	West Hills	no	58	4
2003	LaBarre	no	67	4
2004	West Hills	no	100	4
2004	Deer Creek	no	55	1
2004	Gopher Valley	no	55	1
2005	Lupine Meadows	no	30	16
2005	Lupine Meadows	yes	30	12
Total			395	42