

Monitoring and restoration of Kincaid's lupine (*Lupinus oreganus*) and Hitchcock's blue- eyed grass (*Sisyrinchium hitchcockii*) at Oak Basin: 2018 Annual Report



3/31/19

Report to the Bureau of Land Management,
Upper Willamette Resource Area: Northwest
Oregon District, L16AC00241 and L18AC00073

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PREFACE

This report is the result of an agreement between the Institute for Applied Ecology (IAE) and a federal agency. IAE is a non-profit organization whose mission is conservation of native ecosystems through restoration, 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. Our current activities are concentrated on rare and endangered plants and invasive species.



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Cover photograph: Kincaid's lupine (*Lupinus oreganus*) and Oak Basin from Meadow A.

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EXECUTIVE SUMMARY

This report documents the restoration activities and monitoring conducted by IAE in 2018 at Oak Basin. This site is home to *Lupinus oreganus* (Kincaid's lupine), a threatened species, and *Sisyrinchium hitchcockii* (Hitchcock's blue-eyed grass), a federal species of concern. Kincaid's lupine serves as the primary larval host plant for the endangered Fender's blue butterfly (*Icaricia icarioides fenderi*). Both species are endemic to western Oregon prairies. In 2018, the thirteenth year of monitoring and sixth year of restoration activities occurred at Oak Basin, which is managed by the Northwest Oregon District Bureau of Land Management.

- **Kincaid's lupine:** In 2018, total lupine cover at Oak Basin was 163.4 m², an increase of 11.4 m² from 2017. Cover of Kincaid's lupine increased in Meadow A, and decreased in both Meadows B and C. The total number of mature racemes (inflorescence) decreased to 3,042 mature racemes (down from 3,613 in 2017), the number of aborted racemes increased to 336 (10% of total racemes counted). The cover and reproduction of Kincaid's lupine at Oak Basin have varied substantially from year to year and should be continually monitored to decipher the factors impacting the fluctuations, which could include climate differences, competition from exotic species and/or habitat degradation. Additionally, changes in foliar cover may be related to the presence of introduced perennial grasses; lupine plants growing in competition with these species often appear more spread out, with fewer leaves. The survivorship of a subset of transplanted *L. oreganus* were also monitored on the adjacent private property in 2018; of the 38 plugs monitored, 18 survived (47%).
- ***Sisyrinchium hitchcockii*:** Long-term monitoring plots for *S. hitchcockii* were added to Meadow C in 2012, and monitoring has been conducted annually from 2012-2018. Since 2012, the population declined from a total of 122 individuals to 46 in 2018. There has also been a decline in reproductive stems since initiation of monitoring: in 2012 there were 128 and in 2018 that number was down to 72. The decline in reproductive effort of *S. hitchcockii* and subsequent increase in 2017 for both species suggest that some shared factor(s), such as climate and/or competition with exotic species, could be impacting the success of these populations. Continued monitoring will be essential to document annual population variability to inform future management activities and the perpetuation of these rare species.
- **Habitat quality:** In 2018, as in previous years, there was high cover of exotic grasses (>75% cover) including *Schedonorus arundinaceus* (tall fescue), *Dactylis glomerata* (orchard grass), and *Cynosurus echinatus* (bristly dog's tail). These non-native species were the most prevalent, while the exotic forb, *Leucanthemum vulgare* (oxe-eye daisy), encompassed over 15% cover. Cover of native forbs remained relatively stable at <20%, with *Eriophyllum lanatum* (Oregon sunshine) being the dominant native species. Species richness decreased from 2011-2017 with 105 species observed in 2011, 82 in 2015, 66 in 2017, and 93 in 2018. **Meadow A has seen the largest decrease in species richness from 85 in 2012 to 38 species in 2017;** although richness increased in 2018 (64), this was due to an increase in the number of introduced species.
- **Management treatments:** Management treatments conducted in 2013-2018 included mowing in lupine patches to control exotic perennial grasses and shrubs, flame weeding, limbing of larger

trees, removal of conifers <4" DBH to increase meadow connectivity and reduce encroachment, and hand pulling/grubbing of noxious weeds including black berry and scotch broom. Monitoring results from 2015-2018 showed that flame-weeded areas had lower cover of introduced graminoid species and higher native graminoid cover than adjacent untreated areas. In Meadow B, areas that had been flame-weeded had higher cover of native forb species than untreated areas. Mowing treatments in Meadows A and B did not have a clear effect on cover of native or exotic grasses or forbs.

Recommendations

Based on effects of management actions and the importance of this site for reaching recovery goals for Fender's blue butterfly and Kincaid's lupine, continued management for introduced species, particularly introduced perennial and annual graminoids, is recommended. Activities in 2019 should include continued control of introduced species and tree removal in corridors to increase connectivity between meadows. Efforts to connect meadows should include the control of weeds and the introduction of native plant material. Non-native annual grasses such as *Taeniatherum caput-medusae* (medusahead) and bristly dogtail grass have been reduced significantly in flame weeded plots, and perennial introduced graminoids have also declined. Moving forward, we recommend that invasive species treatment and subsequent seeding of disturbed areas continue as the principal restoration activities for 2019.

Monitoring and restoration of Kincaid's lupine (*Lupinus oreganus*) and Hitchcock's blue-eyed grass (*Sisyrinchium hitchcockii*) at Oak Basin: 2018 Annual Report

REPORT TO THE BUREAU OF LAND MANAGEMENT, NORTHWEST OREGON DISTRICT

INTRODUCTION

This report documents rare plant and community monitoring and restoration activities conducted by the Institute for Applied Ecology (IAE) in 2018 at Oak Basin, a site managed by the Upper Willamette Resource Area in the Northwest Oregon District of the Bureau of Land Management. Oak Basin supports the largest known Kincaid's lupine (*Lupinus oreganus*; Figure 1) population in the Upper Willamette Resource Area. Monitoring at Oak Basin is focused on documenting the population size and reproduction of Kincaid's lupine and habitat quality of the site. This information is used to determine the effectiveness of restoration treatments at the site and to document long-term population trends in support of meeting recovery goals as outlined in the Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington (Recovery Plan, USFWS 2010). In addition to monitoring Kincaid's lupine, IAE also monitors a population of the rare *Sisyrinchium hitchcockii* (Hitchcock's blue-eyed grass) to document population trends.

Upper Oak Basin is a Bureau of Land Management (BLM)-owned property located in Linn County, approximately six miles southeast of Brownsville, Oregon. IAE has been partnering with the BLM to monitor rare plant and animal populations since 2006 and to restore and manage prairie habitat since 2012 at this site. Management actions at the site are consistent with those necessary to support populations of these rare species.

Species status and information

Kincaid's lupine is a member of the legume family (Fabaceae). It is an herbaceous perennial that reproduces by seed. Plants form clumps of basal leaves and eventually produce one or more flowering stems. This species also spreads vegetatively, though it is unknown to what



FIGURE 1. KINCAID'S LUPINE (*LUPINUS OREGANUS*).



FIGURE 2. FENDER'S BLUE BUTTERFLY (*ICARICIA ICARIOIDES FENDERI*).

extent vegetative growth may result in the formation of physiologically distinct clones. Kincaid's lupine requires insects for successful fertilization and seed formation (Kaye 1999). It is found in native prairie remnants in the Willamette Valley and southwestern Washington and in forest openings in Douglas County, Oregon. Because Kincaid's lupine serves as the primary host for Fender's blue butterfly (*Icaricia icarioides fenderi*) larvae, a U.S. Fish and Wildlife Service endangered species (ORBIC 2016; Figure 2), conservation of the lupine is a common goal for the protection of both species. Kincaid's lupine is listed by the Oregon Department of Agriculture and the U.S. Fish and Wildlife Service as a threatened species (ORBIC 2019).

Hitchcock's blue-eyed grass is a rhizomatous perennial forb in the Iris family (Iridaceae; Figure 3). This species reproduces by seed as well as by clonal vegetative growth. It is listed as a federal species of concern by the U.S. Fish and Wildlife Service (ORBIC 2019) and is a Bureau Sensitive Species for the BLM.

Oak Basin has been identified as a potential Functioning Network to meet the de-listing goals for Fender's blue butterfly and the population of Kincaid's lupine currently meets the minimum local population size standard of at least 100 m² of foliar cover (USFWS 2010). Additionally, large patches of Kincaid's lupine occurs on the adjacent Oak Basin Tree Farm that is currently being restored through a cooperative agreement between private landowners, The Nature Conservancy, Oregon Department of Fish and Wildlife, and U.S. Fish and Wildlife's Partners for Fish and Wildlife Program.



FIGURE 3. HITCHCOCK'S BLUE-EYED GRASS. (A) LONG AND NARROW LEAVES WITH PARALLEL VEINS THAT ARE MOSTLY BASAL (B) 3-CHAMBERED CAPSULES UP TO 6 MM LONG CONTAINING BLACK SEEDS (C) FLOWERS HAVE BLUE TO BLUISH-PURPLE TEPALS WITH A FAINT (OR ABSENT) YELLOW "EYE" IN CENTER.

Fender's blue butterfly life cycle

Fender's blue butterflies (FBB) are mature adults in May and June. This is when they fly, eat nectar, and mate. The females oviposit their eggs on the underside of lupine leaves. Eggs are identifiable as small (0.5–1.0 mm) white spheres (Figure 4a). The eggs hatch in a few weeks; hatched eggs resemble unhatched eggs except they are burst in the center, making them look like little white "donuts". The larvae

subsequently feed on the lupine leaves (Figure 4b and 4c) until late June or early July, when they crawl under nearby vegetation and plant litter and enter diapause. They remain in a dormant state until February or early March, when they begin feeding again on the newly emerging lupines. Near the end of April they pupate and reemerge as butterflies (Schultz and Crone 1998).

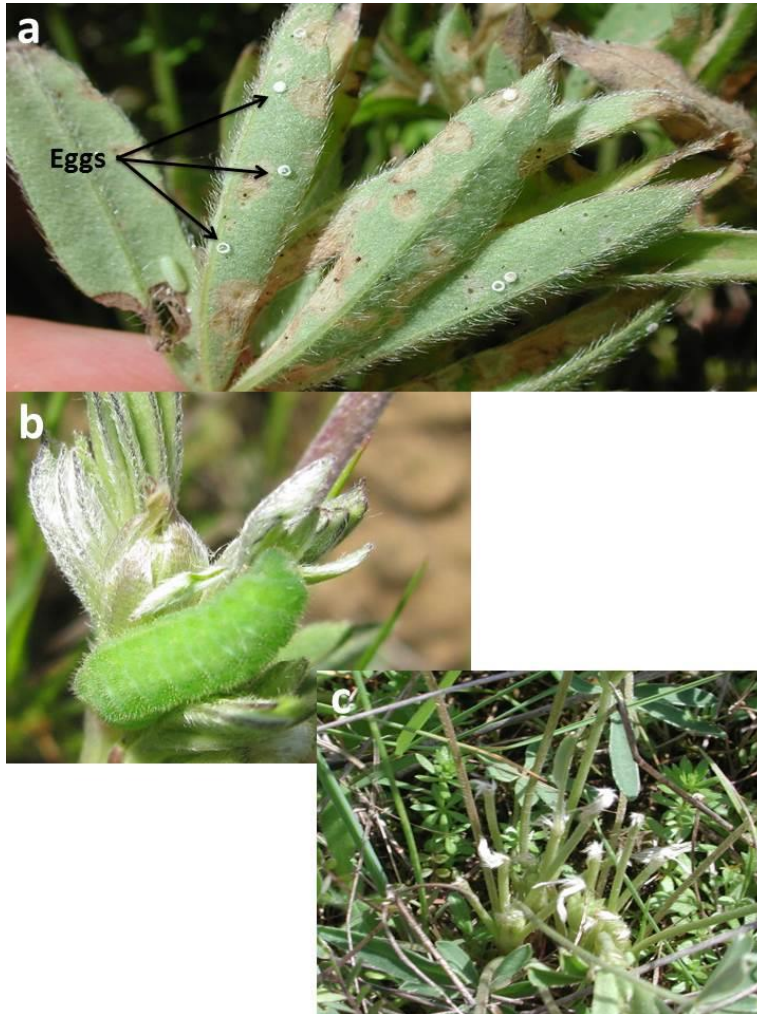


FIGURE 4. FENDER'S BLUE BUTTERFLY ON KINCAID'S LUPINE. (A) FEMALE FENDER'S BLUE BUTTERFLIES OVIPOSIT SMALL WHITE EGGS ON THE UNDERSIDES OF LUPINE LEAVES. HERBIVORY OF KINCAID'S LUPINE BY LARVAE (B) OF FENDER'S BLUE BUTTERFLY RESULTS IN CLUSTERS OF DAMAGED STEMS, LEAVES, AND GROWING POINTS (C) BECAUSE THE LARVAE TYPICALLY FEED ON YOUNG LEAVES AND APICAL MERISTEMS.

Monitoring objectives

The objectives of the monitoring portion of this project are to monitor the population of Kincaid's lupine at Oak Basin and examine overall Kincaid's lupine habitat quality over time. Specifically, we aim to link these data with habitat restoration activities occurring on-site, conducted and facilitated by IAE, and to ensure that the population sustains or increases at or above the minimum targets as laid out in the

Recovery Plan (USFWS 2010). Additionally, in 2012 two monitoring plots were established to assess the status of *Sisyrinchium hitchcockii* and help guide restoration activities.

Management goals and objectives

The goals of restoration actions at Oak Basin are to maintain and improve prairie habitat in support of Kincaid's lupine and in association Fender's blue butterfly populations. The four primary objectives of this project are to:

1. Maintain quality prairie habitat by removing non-native invasive plants
2. Prevent encroachment of woody species into the prairie
3. Increase diversity and abundance of the native plant community
4. Improve connectivity between meadows at Oak Basin

2018 RESTORATION ACTIVITIES

Oak Basin habitats include upland prairie and oak, maple, and Douglas-fir woodlands. Restoration efforts focus on three meadows (Meadows A, B, and C; Figure 5, 6 and 7). In 2018, IAE coordinated and implemented a variety of activities to support restoration and conservation efforts at Oak Basin. Major activities included: flame weeding of annual grass dominated patches, blackberry/Scotch broom grubbing, hand mowing in Kincaid's lupine patches and seeding. Restoration actions are detailed in Table 1. See Figure 65 through 7 for the location of 2018 management actions. Appendix A includes a summary of restoration activities conducted at Oak Basin from 2012 to 2018.

TABLE 1. ON-THE-GROUND RESTORATION ACTIVITIES COMPLETED AT OAK BASIN IN 2018.

Date	Activity	Who	Notes
3/14	Partner coordination and site visit	Jessica Celis, Chris Langdon, and Ian Silvernail	Introduction of Chris Langdon to Upper Oak Basin and proposed actions for the year.
3/27	Sapling removal and hand pulling of weeds	Jessica Celis	Removal of small conifer seedlings from forest edge along Meadows A, B, and C. Grubbed blackberry, hand pulled Italian thistle, and Scotch broom from Meadows B and A.
4/19 5/18 5/24 5/29	Hand pulling weeds and monitoring	Jessica Celis and Walama Restoration Project	In burned plots in Meadow A false dandelion and stork's bill were pulled. Elsewhere in Meadow A populations of Italian thistle, medusa head, scotch broom, and shining geranium were pulled. Monitored for medusa head and annual grass regeneration in burned plots.
5/30	Hand pulling weeds and flame weeding	Jessica Celis and Walama Restoration Project	Hand pulled Italian thistle and flame weeded annual grasses in Meadow A.
6/05	Monitoring	Jessica Celis and Denise Giles	Monitored the lupine plug outplants on Oak Basin Tree Farm.

Date	Activity	Who	Notes
10/16	Marking lupine plots to mow	Jessica Celis	Prepare for treatment of tall fescue by Walama Restoration Project.
10/18	Mowing; hand pulling weeds	Jessica Celis and Walama Restoration Project	Mowed lupine plots in Meadows A, B, and C and grubbed black berry from Meadow B
10/19	Hand pulled weeds	Jessica Celis and Walama Restoration Project	Grubbed blackberry from Meadow B
10/29	Flame weeding and seeding	Jessica Celis and Walama Restoration Project	Flame weeded patches of annual grass in Meadow A and B. Seeded subsequently. Treating for medusa head and other annual grasses
11/15	Hand pulling weeds	Jessica Celis and Walama Restoration Project	Grubbed blackberry in Meadow B

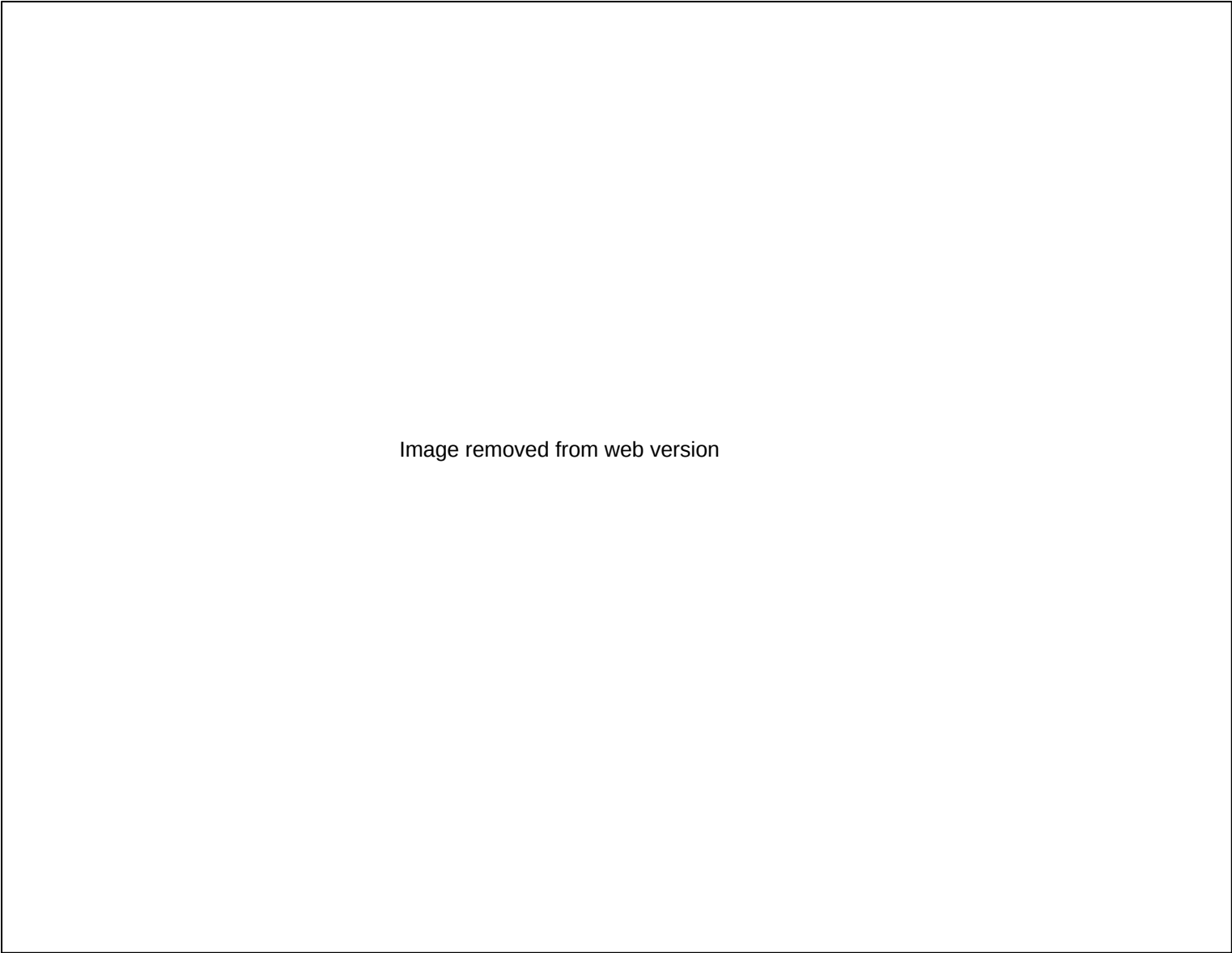


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FIGURE 5. MANAGEMENT ACTIONS COMPLETED IN MEADOW A AT OAK BASIN IN 2018

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FIGURE 6. MANAGEMENT ACTIONS COMPLETED IN MEADOW B AT OAK BASIN IN 2018.

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FIGURE 7. MANAGEMENT ACTIONS COMPLETED IN MEADOW C AT OAK BASIN IN 2018.

Mowing

On October 10, 2018 the area inside several lupine patches was mowed using a string trimmer to reduce standing thatch and provide disturbance (Figure 5-7). The goal is to mow approximately 1/3 of the lupine cover in each of the three meadows annually; these patches rotate so that each patch is mowed every three years. Appendix B indicates the cover and raceme count of Kincaid's lupine patches and the year patches were mowed (Appendix B).

Mechanical weed removal

A variety of mechanical weed treatments were carried out on several invasive species at Oak Basin (Table 1). A large patch of blackberry in Meadow B, located above lupine patch 001, was grubbed out of the ground using shovels (see Figure 6. Management actions completed in Meadow B at Oak Basin in 2018.. Blackberry roots have been grubbed in this patch annually since 2013. *Lupinus oreganus* and this population of blackberry meet on the southern end of the blackberry patch; individual *L. oreganus* were marked with pin flags in the summer of 2017 so as to allow grubbing to occur while avoiding damage to lupines. In Meadow A, small populations of Scotch broom and Italian thistle were hand pulled before the plants produced reproductive parts (Figure 5). In Meadow B, a once dense population of Italian thistle existing near annual grass patch B3 was pulled before the onset of flowering and seed production. Additionally, in early spring conifer seedlings and saplings were cut from within the meadow and along the meadow-forest edge in all meadows (Figure 7).

Flame weeding

A total of 0.67 acres was burned in 2018. Three patches of dense annual grass in Meadow A (A1, A3.5, and A4) were flame weeded twice in 2018: once during the spring (May 30, 2018; Figure 8) and again during the fall (October 29, 2018; see Figure 5 and 6). Additionally, on October 29, in Meadow B annual grass patch B3 was spot flame weeded to reduce the cover of re-establishing annual grasses. This process was also started for patch B4, but due to equipment malfunction was not completed. Patch A3.5 was established this year to connect patches A3 and A4. Plot A1 was flame weeded once in 2013 and 2014 in the spring and then seeded. However, this year it was determined that another treatment was necessary to combat re-establishing annual grasses.



FIGURE 8. ANNUAL GRASS PATCH A4 AFTER FLAME WEEDING IN MAY 2018.

Seeding

On October 29, 2018 a mix of native grass and forb seeds were broadcast in plots A3.5 (0.14 acres), A4 (0.30 acres), A1 (0.09), and B3 (0.14 acres) (Figure 5 and 6). A total of 7.78 lbs of grass seed and 4.21 lbs of forb seed was sown on 0.67 acres. See Table 3 for species included in the seed mix. All plots were blackened from the final propane torch treatment and had almost no above ground vegetation and no thatch prior to seeding (Figure 8).

TABLE 2. SPECIES SEEDED IN PLOTS A1, A 3.5, A4, AND B3 ON OCTOBER 29, 2018. ALL WEIGHTS ARE IN BULK POUNDS.

Species	Growth form	Quantity (lbs)
<i>Danthonia californica</i>	Graminoid	1.87
<i>Elymus glaucus</i>	Graminoid	1.45
<i>Eriophyllum lanatum</i>	Forb	0.28
<i>Koeleria micrantha</i>	Graminoid	0.09
<i>Plectritis congesta</i>	Forb	0.46

Species	Growth form	Quantity (lbs)
<i>Prunella vulgaris</i>	Forb	0.38
<i>Wyethia angustifolium</i>	Forb	3.27

MONITORING METHODS

Kincaid's lupine population monitoring

THE MONITORING AT OAK BASIN IS MEANT TO BE A COMPLETE CENSUS OF THE *LUPINUS OREGANUS* POPULATION. IN 2006, MEADOWS A, B, AND C WERE SURVEYED FOR THE PRESENCE OF KINCAID'S LUPINE. PLOTS WERE THEN ESTABLISHED AROUND LUPINE PATCHES. ADDITIONAL PLOTS HAVE BEEN ADDED AS NEW LUPINE PATCHES HAVE BEEN LOCATED (APPENDIX B: LUPINE COVER AND RACEME COUNTS BY PLOT FROM 2013-2018. SHADED CELLS INDICATE WHICH PLOTS WERE MOWED IN THE PRECEDING FALL.

	2013		2014		2015		2016		2017		2018	
	Cover (m ²)	Mature Racemes	Cover (m ²)	Mature Racemes	Cover (m ²)	Mature Racemes	Cover (m ²)	Mature Racemes	Cover (m ²)	Mature Racemes	Cover (m ²)	Mature Racemes
Meadow A	42.9	71	80.4	1108	49.2	129	47.3	209	87.5	1996	110.3	1984
7	1.1	10	2.9	36	1.8	10	1.9	12	2.8	201	1.8	62
8	0.3	3	0.2	1	0.1	0	0.1	0	0.3	4	0.4	6
9	4.7	2	6.4	146	3.2	24	2.2	5	4.7	49	6.0	30
10	0.4	0	0.8	18	0.4	3	0.6	0	0.5	8	0.6	3
369											10.9	50
406	0.7	1	0.3	0	0.0	0	0.1	2	0.3	1	0.4	0
450	10.8	23	11.3	30	7.5	21	3.9	22	6.2	29	7.4	7
451	0.7	0	1.6	4	0.6	0	0.9	0	1.4	16	1.4	0
452	3.4	6	10.0	93	8.5	9	3.8	0	11.1	129	10.4	34
454	1.8	4	5.7	10	2.6	0	1.3	0	6.8	36	6.4	3
459	9.7	6	19.3	361	11.9	9	16.8	0	26.3	1069	39.3	669
460	2.4	2	4.8	192	3.0	12	2.5	117	6.5	206	6.4	785

	2013		2014		2015		2016		2017		2018	
	Cover (m ²)	Mature Racemes	Cover (m ²)	Mature Racemes	Cover (m ²)	Mature Racemes	Cover (m ²)	Mature Racemes	Cover (m ²)	Mature Racemes	Cover (m ²)	Mature Racemes
464	5.3	4	13.8	118	6.4	2	7.9	0	17.4	126	12.0	23
509	1.0	8	1.5	52	1.6	30	0.7	51	2.3	56	5.0	239
510	0.3	0	1.4	14	1.3	4	0.0	0	0.1	1	0.8	8
511	0.4	2	0.5	33	0.3	5	4.5	0	0.8	65	1.2	65
Meadow B	25.5	122	51.6	627	21.4	120	18.9	197	34.7	736	27.9	587
1	8.6	20	31.3	309	11.8	31	8.8	43	23.2	441	12.1	379
2	0.5	1	0.5	1	0.1	1	0.0	0	0.1	3	0.0	1
3	2.0	5	3.2	21	1.6	7	1.5	13	1.3	15	0.5	5
4	1.7	2	2.5	23	0.7	7	0.9	0	1.5	40	0.4	2
5	4.3	2	6.2	114	4.3	50	1.7	25	1.6	19	4.5	22
6	3.6	51	4.6	125	2.9	24	2.3	21	2.5	51	4.3	107
399	4.9	41	3.3	34	0.0		3.7	95	4.6	167	6.1	71
Meadow C	11.2	44	17.8	311	21.7	177	14.0	217	29.5	881	25.2	471
400	0.126	0	0.1142	1	0.0385	1	0.0406	3	0.0478	0	0.0926	0
431	1.782	0	2.7392	20	3.1259	8	1.5526	0	3.8819	62	2.644	32
432	5.0704	42	10.132	173	9.3643	86	7.4113	187	12.243	408	12.432	322
433	4.1722	2	4.8172	117	9.0752	82	4.2815	14	12.341	408	8.6652	78
594							0.7351	13	0.866	1	1.2694	38

APPENDIX APPENDIX D. LOCATION, DIMENSIONS, AND MONITORING NOTES FOR KINCAID'S LUPINE AND HITCHCOCK'S BLUE-EYED GRASS (SIHI; IN BOLD) PLOTS AT OAK BASIN.

Meadow	Plot Number	Dimensions	origin (Nad27)	Notes
A	7	23m x 12m	504288 E 4906986 N	measured in 2m increments
A	8	Circular, 2m radius	504259 E 4907001 N	fallen tree covering part of plot
A	9	18m x 14m	504286 E 4906960 N	measured in 2m increments
A	10	Circular, 2m radius	504312 E 4906952 N	
A	459	13m x 12m	504246 E 4906964 N	measured in 3m increments
A	454	20m x 13m	504210 E 4906979 N	3 individuals 8m and 48° from origin
A	464	20m x 26m	504183 E 4906999 N	measured in 2m increments
A	450	90m x 7m	504232 E 4907030 N	measured in 5m increments
A	451	8m x 7m	504132 E 4906987 N	measured in 2m increments
A	452	25m x 35m	504156 E 4907003 N	measured in 2m increments
A	460	22m x 16m with extension	504274 E 4906955 N	measured in 4m increments
A	406	Circular, 2m radius	504101 E 4907056 N	
A	509	Circular, 1.5m radius	504199 E ¹ 4907048N	new in 2011
A	510	8m x 6m	503967 E ¹ 4907105 N ¹	new in 2011, measured in 1m increments N-S
A	511	3m x 1m	504702 E ¹ 4907160 N ¹	new in 2011, measured in 1m segments N-S
B	1	60m x 18m+	504420 E 4906668 N	measured in 5m increments
B	2	Circular, 2.5m radius	504503 E 4906649 N	
B	3	12m x 18m (20m)	504514 E 4906646 N	measured in 2m increments
B	4	Circular, 3m radius	504545 E 4906630 N	

Meadow	Plot Number	Dimensions	origin (Nad27)	Notes
B	5	12m x 9m	504597 E 4906570 N	measured in 2m increments
B	6	11m belt transect	504628 E 4906559 N	measured 2m to each side
B	399**	11m belt transect	504326 E 4906806 N	measured to E and W, in 1-2m increments.
B	558	2m radius	504413 E ¹ 4906842 N ¹	new in 2014
C	594	12m belt	See map	New in 2017
C	233	1m radius	See map	New in 2017
C	1(185)²	15m x 4m	504639 E¹ 49065659N¹	measured in 1m increments
C	2 (186)²	2m radius	504655 E¹ 4906555N¹	divided into NW, NE, SW, and SE sections
C	433	8m belt transect	504712 E 4906379 N	measured to E and W, in 2m increments
C	432	8m x 9m	504649 E 4906401 N	measured in 2m increments
C	431	18m belt transect	504732 E 4906378 N	measured to N and S, in 1m increments
C	400	1m radius	504609 E ¹ 4906553 N ¹	new in 2012; along tree line in <i>Rupertia physodes</i>

¹ Coordinates are in NAD83 instead of NAD27.

² Plots 1 (185) and Plot 2 (186) in Meadow C are SIHI plots.

** There is a large patch of lupine on the SW end of Meadow B which is on private property. Plot 399 captures the lupine nearest the public/private boundary.

APPENDIX E. LOCATIONS OF KINCAID'S LUPINE PLANTINGS (ORANGE POLYGONS PLANTED IN 2017) ON MERZENICH PROPERTY. SURVIVORSHIP OF TRANSPLANTS WAS MONITORED IN 2018.

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APPENDIX F. TOTAL NUMBER OF MATURE RACEMES AND PERCENT OF RACEMES ABORTED OF KINCAID'S LUPINE, AND TOTAL LUPINE COVER AND NUMBER OF RACEMES PER M² OF LUPINE FOLIAR COVER AT OAK BASIN FROM 2006-2018.

	Meadow A		Meadow B		Meadow C		Grand Total	
	Mature Racemes	Percent Aborted	Mature Racemes	Percent Aborted	Mature Racemes	Percent Aborted	Mature Racemes	Percent Aborted
2006	245	9%	375	13%	145	21%	765	14%
2007	881	9%	1,482	4%	810	5%	3,173	6%
2008	891	9%	1,027	6%	432	9%	2,350	8%
2009	415	18%	1,004	7%	55	42%	1,474	12%
2010	1,860	5%	1,678	4%	108	28%	3,646	5%
2011	1,978	5%	1,845	4%	192	18%	4,015	5%
2012	1,328	7%	969	7%	127	24%	2,424	8%
2013	71	59%	122	39%	44	50%	237	49%
2014	1,108	8%	627	11%	311	12%	2,046	10%
2015	129	47%	120	35%	177	11%	426	32%
2016	209	42%	197	31%	217	20%	623	32%
2017	1,996	8%	736	11%	881	6%	3,613	8%
2018	1,984	8%	587	14%	471	11%	3,042	10%

	Meadow A		Meadow B		Meadow C		All Meadows	
	Cover (m ²)	Mature racemes/m ²	Cover (m ²)	Mature racemes/m ²	Cover (m ²)	Mature racemes/m ²	Cover (m ²)	Mature racemes/m ²
2006	39.3	6	44.9	8	11.5	13	95.7	8
2007	37.3	24	37.7	39	21.1	38	96.1	33
2008	45.3	20	45.9	22	10.6	41	101.8	23
2009	49.5	8	50.1	20	10.7	5	110.3	13
2010	65.3	28	49.6	34	12.0	9	126.9	29
2011	86.8	23	60.3	31	15.2	13	162.3	25
2012	86.5	15	70.0	14	13.6	9	170.1	14
2013	42.9	2	25.5	5	11.2	4	79.6	3
2014	80.4	14	51.6	12	17.8	17	149.8	14
2015	49.2	3	21.4	6	21.7	8	92.3	5
2016	47.3	4	18.9	10	14.0	15	80.2	8
2017	87.5	23	34.7	21	29.5	30	151.7	24
2018	110.3	18	27.9	21	25.2	19	163.4	19

APPENDIX G: COUNT OF NUMBER OF SISYRINCHIUM HITCHCOCKII BY SIZE CLASS IN MEADOW C AT OAK BASIN FROM 2012-2018. R NUMBERS REPRESENT THE NUMBER OF INFLORESCENCES RECORDED PER STEM (R1, R2, R3, ETC.).

Size Class	2012	2013	2014	2015	2016	2017	2018
Vegetative	42	47	26	44	30	15	17
R1	55	40	17	13	8	21	12
R2	14	10	9	5	2	20	10
R3	7	5	5	1	1	8	4
R4	1	1	7	0	1	1	1
R5	1	1	0	1	0	1	1
R6	1	0	12	0	0	0	0
R7	0	0	7	0	0	0	0
R8	0	1	0	0	0	0	0
R9	1	0	0	0	0	0	0
R10	0	0	0	0	0	0	0
R11	0	0	0	0	0	0	0
R12	0	0	1	0	0	0	0
R13	0	0	0	0	0	0	0
R14	0	0	1	0	0	0	0
R19	0	0	0	0	0	0	1
Total Reproductive Individuals	80	58	59	20	12	51	29
Total Reproductive Stems	128	92	225	31	19	89	72
Total number of plants	122	105	85	64	42	66	46

APPENDIX H: AVERAGE PERCENTAGE OF INTRODUCED AND NATIVE FORB AND GRAMINOID SPECIES IN LUPINE HABITAT FROM 2011-2018 IN MEADOWS A, B, AND C. ERROR BARS REPRESENT 95% CI.

Appendix and D). Larger plots are rectangular and marked with fiberglass posts, rebar, or conduit in all four corners. Smaller lupine patches are monitored in either circle or belt transects. Circular plots were marked in the center and all plants were included by setting an appropriate radius. Belt transects were marked on opposite ends, a tape was stretched between the posts, and all of the lupine on either side of the tape was recorded. Each plot origin was tagged with a pre-numbered aluminum tag. Plot notes can be found on the plot maps (Appendix C). When plants are found outside of existing plots, plot boundaries are either modified or new plots added to accommodate these plants.

Plots were established such that all lupine at the site is monitored for foliar cover (m^2) as well as the count of mature and aborted racemes. Lupine foliar cover was determined by measuring the approximate length (cm) and width (cm) of area occupied by a lupine plant or plants if clustered. Foliar cover of lupine (as opposed to counting 'individual' plants, of this rhizomatous species), is the standard for lupine monitoring as recommended by the Recovery Plan (USFWS 2010). The percentage of aborted racemes is calculated by taking the number of aborted racemes divided by the total number of mature racemes plus the number of aborted racemes and multiplying by 100.

Oak Basin Tree Farm plug survival monitoring

In the spring of 2017, 68 plugs of *L. oreganus* were planted on Oak Basin Tree Farm property (Appendix E). Plugs were grown by IAE from seed collected the previous summer from the same property. In May of 2018 Denise Giles and Jessica Celis monitored survivorship of 12 of the 14 plots planted; each live plant (total plants to survive) and plant marker (total planted) in the plots were counted. These plots were sprayed with Fusilade, a grass specific herbicide (dates unknown), to treat non-native perennial grasses surrounding the lupine by landowner Jim Merzenich.

Sisyrinchium hitchcockii monitoring

Two permanent plots were established in 2012 to monitor the small population of the Bureau Sensitive species, *S. hitchcockii*, in Meadow C at Oak Basin. The first was a 15m long, 8m wide belt transect with rebar marking both ends. The plot was monitored in 1m sections on the east and west sides of the tape. The origin of the transect is on the south end, tagged with #185. The plot extends at a bearing of 340° for 15m; the end rebar is not tagged. The second plot was a two meter radius circular plot with the rebar placed in the center and tagged with #186; plants were measured in four quadrants. There is a small patch of lupine in this same area, and the circular plot #186 serves as a marker for both *L. oreganus* and *S. hitchcockii*. *Sisyrinchium bellum* is also present in the area, for this reason monitoring occurred at the time of flowering (late June/early July) to ensure proper identification of the species.

Due to the rhizomatous growth of *Sisyrinchium*, plants greater than 20cm apart were counted as distinct individuals unless there was clear evidence otherwise (e.g. exposed rhizomes; Groberg et al. 2013). Plants were noted to be either vegetative or reproductive. Those that were reproductive were also given a number to represent the inflorescences per stem of each plant (R1, R2, R3 etc.), however individual stems may have more than one flower. In addition, a reproductive plant is likely to have vegetative stems associated with it.

Habitat quality monitoring

From 2016-2018, habitat monitoring has focused on assessing the quality of occupied and unoccupied lupine habitat in all meadows and by assessing the plant community of areas undergoing active habitat restoration. From 2011-2015, prior to monitoring the effects of active habitat restoration, habitat monitoring focused on areas designated as Kincaid's lupine habitat and areas that were not occupied by lupine ("non-lupine" habitat). To assess changes in habitats, random points are generated each season across all meadows prior to sampling. At each random point, we ocularly estimate cover for each species, and record the habitat type (occupied or unoccupied). Occupied Lupine habitat/unoccupied habitat was designated based on presence (or absence) of lupine within ~10m of the sample plot, unless habitat characteristics indicated otherwise. These data have been used as a baseline to target and test restoration efforts at the site and to understand changes in the plant community over time.

The purpose of the community assessment is to:

1. Quantify recovery targets for associated prairie species: percent cover native vs. exotic. Accomplished by quantifying percent cover of all plant species and ground cover types (litter, bare ground, moss, and rock) in each meadow.
2. Assess pre- and post-treatment effects (fire, mowing, herbicides, etc. in the future). Accomplished by quantifying percent cover of all plant species and ground cover types (litter, bare ground, moss, and rock) in treated (and untreated) areas.

RESULTS

Kincaid's lupine population monitoring results

Kincaid's lupine cover and raceme counts have fluctuated over the years (range: 79.6-170.1). Cover was 163.4m² across all meadows in 2018. This is up 41.4% (95.7m²) from the first year of monitoring in 2006 and by 7.2% (151.7m²) in 2017 (Figure 9, Appendix F). The total number of racemes has followed a similar pattern as the lupine foliar cover at Oak Basin (Figure 10) (range: 237-4,015). In 2018, there were 3,042 flowering racemes of lupine in all meadows, 10% of which aborted. The percentage of aborted racemes (flowering stems that do not fully mature) has varied from 3%-59% of the total number of racemes counted over the course of this study (Appendix F).

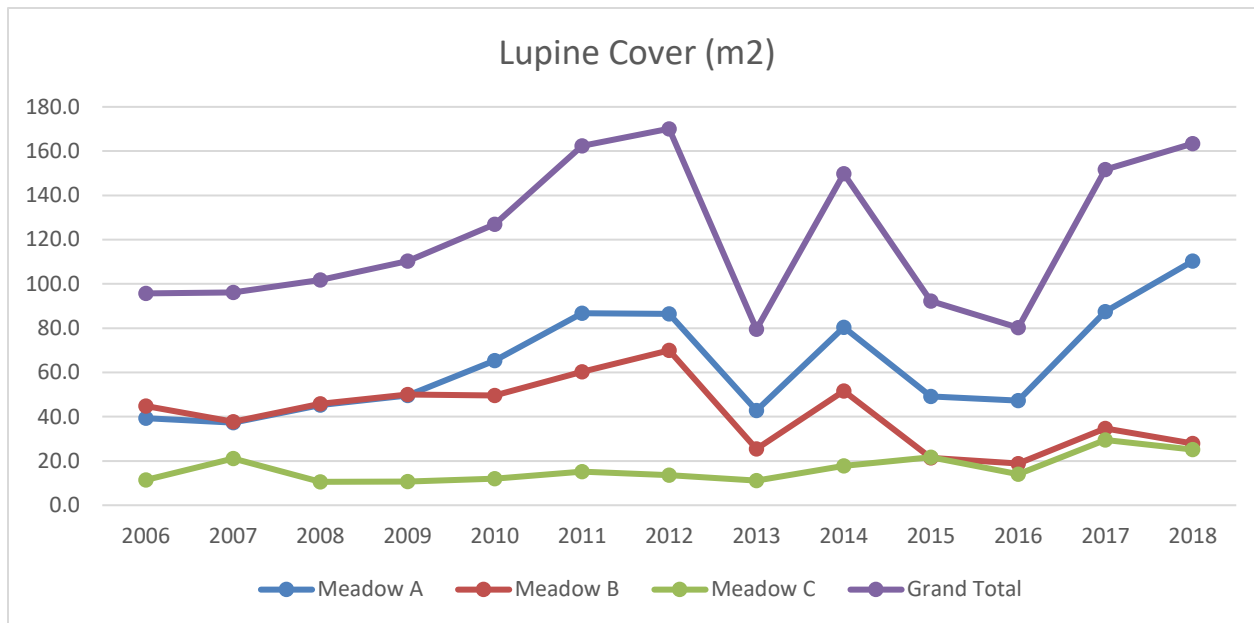


FIGURE 9. LUPINE COVER (M²) IN EACH MEADOW AND TOTAL COVER FOR ALL MEADOWS AT OAK BASIN FROM 2006-2018.

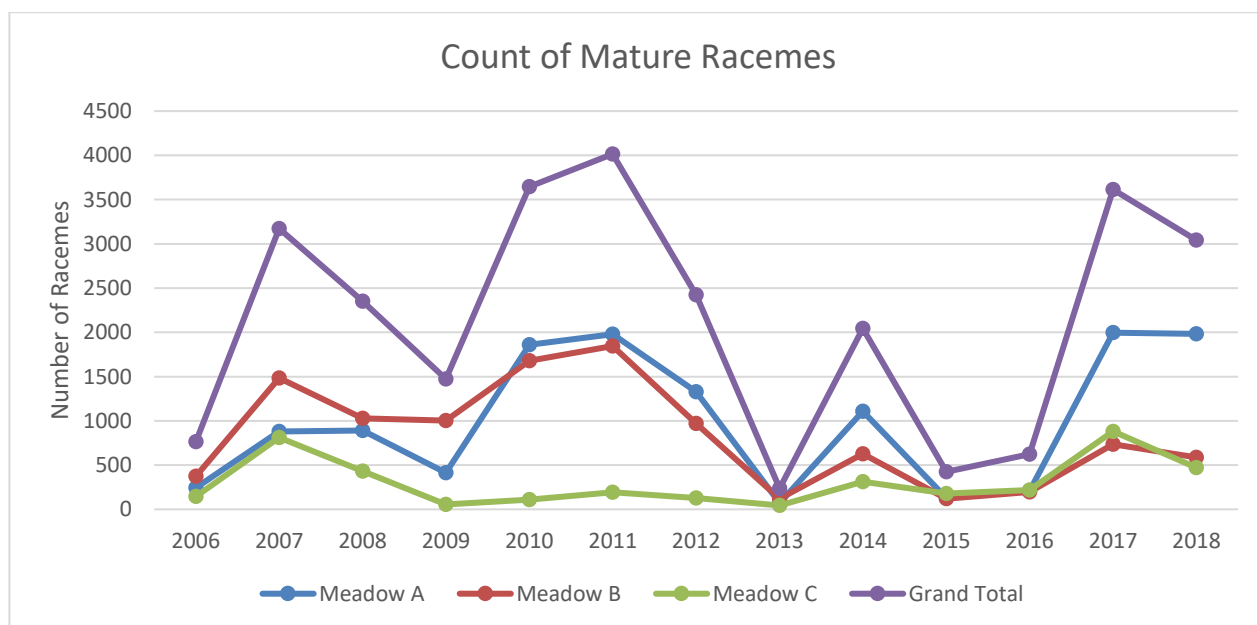


FIGURE 10. TOTAL MATURE RACEMES COUNTED IN EACH MEADOW AT OAK BASIN FROM 2006-2018.

Lupine plug survival at Oak Basin Tree Farm

Of the 38 outplanted lupine plugs monitored in 2017 at the Oak Basin Tree Farm, 18 plants survived (47.4% survival).

Sisyrinchium hitchcockii population results

Since initiation of monitoring in 2012, the population of *S. hitchcockii* has fluctuated some, but has mostly declined (Figure 11, Appendix G). Most plants observed in the 4-meter-wide belt transect were found

within 2 meters of the transect tape. In 2012 a total of 122 plants were observed, with a total of 128 reproductive stems. In 2018, a total of 46 plants were observed with a total of 72 reproductive stems.

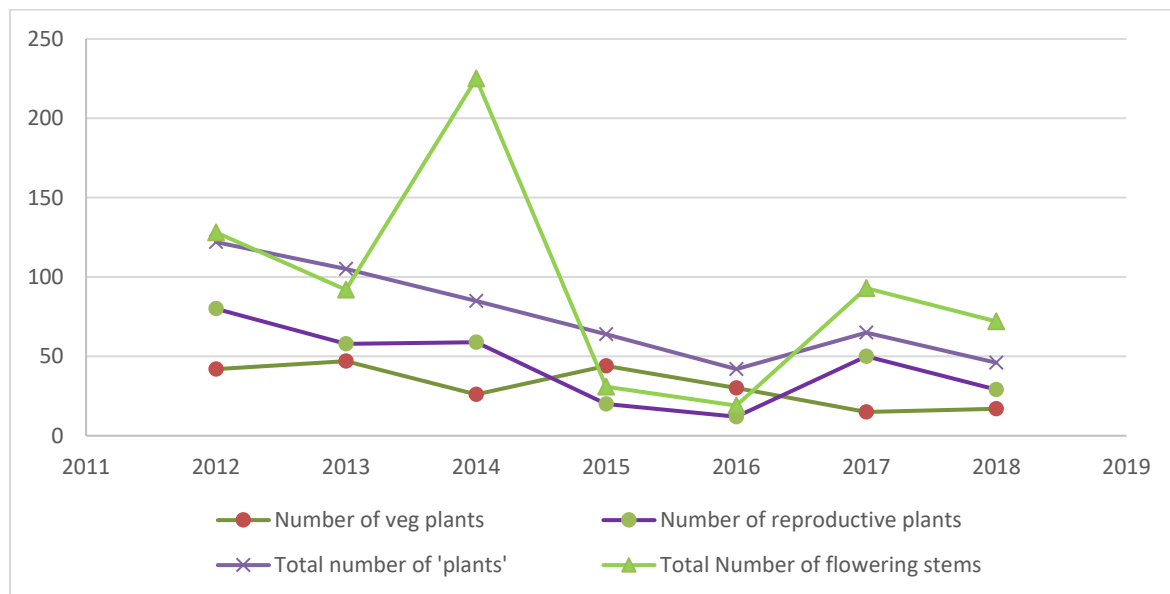


FIGURE 11. POPULATION TRENDS FOR *S. HITCHCOCKII* IN MEADOW C AT OAK BASIN FROM 2012-2018.

Habitat assessment results

Total species richness for all meadows has fluctuated from 2011 (96) to 2018 (93). There was a general decline from 2011-2017 (from a high of 99 in 2012, low of 55 in 2016), and then an increase from 2017 to 2018 (Table 3). Species richness in Meadow A, decreased from 82 species in 2011 to 64 in 2018. Meadows B and C followed a similar downward trend at Meadow A from 2011-2017, but increased in 2018 to some of the greatest species richness observed for those meadows. In Meadows B and C, increases in 2018 were associated with increases in native species, while in Meadow A, richness increases were related to increases in the number of introduced species (Table 3).

Overall community composition in 2018 were similar to previous years, with only introduced graminoids showing a significant decrease in Meadow A ($85\% \pm 15$ in 2017 to $56\% \pm 9$ in 2018) and C ($65\% \pm 13$ in 2017 to $38\% \pm 11$ in 2018) (Table 4, Appendix H). Cover of native forbs in all meadows has ranged from 5-30% across all years. In each year, the cover of exotic forb species in Meadow C has been consistently lower (range 7%-15%) than the cover of exotic forb species in Meadows A and B (range 10%-31% and 15%-37% respectively). Native graminoid cover is low in all three meadows, with a range of 3%-16% across all years.

Graminoid cover is higher than forb cover in all meadows (Appendix H). *Schedonorus arundinaceus* is an especially competitive introduced species and is dominate in lupine habitats with a total average cover ranging from 32-56% in all Meadows in 2018. *Festuca roemerii* and *Bromus carinatus*, were the most abundant native grasses across all three meadows in lupine habitat.

In Kincaid's lupine habitat, the native forbs, *Pteridium aquilinum*, *Sidalcea malviflora* ssp. *virgata*, and *Eriophyllum lanatum* were the most abundant in all years. Despite the presence of these native species, the

introduced, exotic forb *L. vulgare* dominated total forb cover totaling at least 2/3 of introduced forb cover in plots monitored from 2011-2018.

TABLE 3. SPECIES RICHNESS AT OAK BASIN FROM 2011-2018. MEADOW C WAS NOT MONITORED IN 2016.

Species Richness								
	2011	2012	2013	2014	2015	2016	2017	2018
Meadow A	82	80	66	61	53	44	39	64
Meadow B	65	70	62	54	72	34	52	70
Meadow C	58	68	59	63	31	N/A	46	60
All Meadows	96	99	84	88	82	55	69	93
Count of Native Species								
	2011	2012	2013	2014	2015	2016	2017	2018
Meadow A	43	42	34	33	28	23	19	28
Meadow B	37	36	29	28	42	10	31	40
Meadow C	32	36	35	37	14	N/A	25	33
All Meadows	55	57	47	51	50	24	37	52
Count of Introduced Species								
	2011	2012	2013	2014	2015	2016	2017	2018
Meadow A	39	38	32	28	25	21	20	36
Meadow B	28	34	33	26	30	24	21	30
Meadow C	26	32	24	26	17	N/A	21	27
All Meadows	41	42	37	37	32	31	32	41

TABLE 4. AVERAGE PERCENT COVER AND 95% CONFIDENCE INTERVAL BY PLANT MANAGEMENT GROUP AT OAK BASIN IN LUPINE HABITAT FROM 2011-2018.

	Introduced Forb		Native Forb		Introduced Graminoid		Native Graminoid		Introduced Perennial Graminoid		Introduced Annual Graminoid	
	% Cover	95% CI	% Cover	95% CI	% Cover	95% CI	% Cover	95% CI	% Cover	95% CI	% Cover	95% CI
Meadow A												
2011	13.3	5.0	8.4	2.9	37.4	13.8	5.7	2.0	34.4	14.5	3.0	3.1
2012	23.2	9.6	14.8	7.6	70.1	13.3	6.9	6.1	69.1	13.9	1.0	0.9
2013	28.4	10.4	14.3	6.9	88.8	9.3	3.8	1.9	86.8	9.7	2.0	1.4
2014	31.1	10.2	16.5	7.8	75.1	17.9	14.2	11.4	56.9	24.2	18.2	13.8
2015	10.6	4.2	30.1	14.0	87.7	19.7	12.7	13.7	85.8	20.8	1.9	2.2
2017	16.6	10.8	9.4	4.6	84.6	14.9	2.1	2.5	84.5	14.9	0.1	0.1
2018	14.7	4.5	10.5	4.5	55.5	9.1	4.6	2.2	54.1	9.6	1.4	0.8
Meadow B												
2011	15.5	7.9	13.3	2.4	42.3	16.9	3.3	3.0	41.0	17.8	1.4	1.7
2012	27.1	9.9	18.8	6.1	72.0	12.4	4.7	2.6	71.5	12.5	0.5	0.3
2013	34.4	12.8	22.9	8.2	73.3	14.7	15.9	13.6	72.6	15.0	0.7	0.6
2014	36.9	23.2	29.1	16.1	79.5	23.1	4.2	1.6	75.5	28.7	4.0	6.3
2015	23.9	10.2	23.6	12.0	98.4	11.2	10.9	13.4	97.9	11.6	0.4	0.5
2017	25.6	12.3	21.9	12.1	82.9	14.3	5.3	2.0	82.0	14.5	0.9	1.3
2018	15.7	6.4	21.6	10.3	64.1	14.8	2.8	1.5	61.3	16.4	2.8	3.6
Meadow C												
2011	8.8	4.9	12.5	6.5	43.7	10.1	4.3	4.4	42.4	10.3	1.2	1.0
2012	12.2	6.1	18.4	7.1	72.8	12.8	6.7	3.0	69.9	12.4	2.9	1.6
2013	15.2	7.4	19.8	8.7	74.4	15.7	5.7	2.1	72.8	15.6	1.6	0.9
2014	15.4	10.6	30.2	12.3	88.8	13.0	10.3	4.8	84.6	13.4	4.2	4.7
2015	7.0	4.9	5.1	3.9	103.2	25.3	6.6	5.0	102.6	24.4	0.7	0.9
2017	8.1	4.0	24.4	15.5	65.2	13.2	7.0	2.9	53.6	14.7	11.6	9.2
2018	5.7	2.1	12.8	7.6	38.4	11.4	6.7	2.7	34.1	11.9	4.3	2.9

DISCUSSION

Population trends

Kincaid's lupine at Oak Basin

Over the course of the study there have been periodic fluctuations in Kincaid's lupine total cover and raceme counts (range; 79.6m² - 170.1m², 237- 4,015 racemes) (**Error! Reference source not found.**Appendix F. Total number of mature racemes and percent of racemes aborted of Kincaid's lupine, and total lupine cover and number of racemes per m² of lupine foliar cover at Oak Basin from 2006-2018. Some of these fluctuations could potentially be linked to climatic stresses; for instance, 2015 and 2016 had high temperatures and drought conditions and we observed low cover and raceme counts those years. However, a number of potential factors, including habitat management: the removal of introduced grasses, and limbing of trees adjacent to existing patches of lupine, other climatic variables, pollinator access, or other factors not identified are likely impacting the fluctuations we are seeing in lupine cover and reproduction. Over the course of the study there have been periodic fluctuations in Kincaid's lupine total cover, however decreases in foliar cover, combined with low raceme production should trigger a re-evaluation of management actions.

Direct competition from introduced grasses, which have been steadily increasing in recent years, could lead to reduced cover of Kincaid's lupine, and the tall stature of these perennial species could potentially reduce reproduction by limiting access for pollinators (Sletvold et al. 2013). Nectar surveys in 2011 indicate that while nectar species are present at the site, they may not be enough available (both in number and nectar resources) through the duration of the flight period for Fender's blue butterfly (Giles-Johnson et. al 2011), and this is could also be true for other pollinators.

Lastly, we have noted an inverse relationship between production of mature racemes and the percentage of aborted racemes. Years that produced a large quantity of mature racemes tend to be associated with low percentages of aborted racemes. Conversely, in years when few racemes are produced, as in 2013 and 2015, the percent of aborted racemes was 59% and 29% respectively (Figure 10, Appendix F. Total number of mature racemes and percent of racemes aborted of Kincaid's lupine, and total lupine cover and number of racemes per m² of lupine foliar cover at Oak Basin from 2006-2018.).

Lupine plug survival at Oak Basin Tree Farm

Although no quantitative data was taken, we observed that while non-native perennial grasses were in low abundance in the lupine out-planted plots at Oak Basin Tree Farm, likely due to the grass-specific herbicide treatment, blooming *Leucanthemum vulgare* (oxe-eye daisy) was highly abundant compared to the surrounding areas. In fact, oxe-eye daisy enabled us to find the plots that had been treated and outplanted because the density of their inflorescence was higher than in the surrounding area (Figure 12).



FIGURE 12. DENISE GILES (IAE STAFF) APPROACHING AN OUTPLANTED LUPINE PATCH AT OAK BASIN TREE FARM. THIS PHOTO ILLUSTRATES THE PREVELANCE OF LEUCANTHEMUM VULGARE (OXE-EYE DAISY) AFTER THE APPLICATION OF FUSILADE, A GRASS SPECIFIC HERBICIDE IN THE ~6M DIAMETER PLOT.

Sisyrinchium hitchcockii

We have been monitoring *S. hitchcockii* for six years, and our data show that the *S. hitchcockii* population has been in decline. As a caveat, it is acknowledged by Groberg et. al. that the methodology we currently use may under-represent the true number of individuals present. *Sisyrinchium hitchcockii* plants may spread through rhizomatous growth into neighboring plants, potentially resulting in the grouping of separate individuals during monitoring. Despite the potential limitations of the sampling method in regards to the total number of individual genets, this does not effect the total count of reproductive stems of the population, which is an important indicator of population health; the number of reproductive stems (and the number of plants) has decreased over the course of the study (Figure 11, Appendix G: Count of number of *Sisyrinchium hitchcockii* by size class in meadow C at oak Basin from 2012-2018. R numbers represent the number of inflorescences recorded per stem (r1, r2, r3, etc.).).

It remains vital to monitor the *S. hitchcockii* population to track population variability in coming years to ensure that these populations are remaining viable and to illustrate the need for active management of



FIGURE 13. *SISYRINCHIUM HITCHCOCKII* (HITCHCOCK'S BLUE-EYED GRASS) AT OAK BASIN.

the population. Despite the slight increase in the number of plants from 2016-2017, the decrease in plants and reproductive stems in 2018 could be a concern for the longevity of this population (Figure 13).

Habitat quality assessment

The overall habitat quality at the site is poor to moderate, with high cover of introduced shrubs and forbs including Himalayan blackberry (*Rubus armeniacus*) and oxeye daisy (*Leucanthemum vulgare*), introduced perennial and annual graminoids including tall fescue (*Schedonorus arundinaceus*), orchard grass (*Dactylis glomerata*) and bristly dogtail (*Cynosurus echinatus*). From 2011-2015 cover of introduced graminoid species showed an increase in all meadows in areas designated as lupine habitat (Table 4; Appendix H: Average percentage of introduced and native forb and graminoid species in lupine habitat from 2011-2018 in meadows A, B, and C. Error bars represent 95% CI.). Meadows A, B and C increased in exotic graminoid cover with an increase from 36% to 88% in Meadow A, 42% to 98% in Meadow B, and 44% to more than 100% in Meadow C from 2011-2015. Additionally, the cover of native forb species declined in Meadow C lupine habitat from a high of 30% in 2014 to just 3.5% in 2015.

Despite slight decreases in introduced graminoid cover in lupine habitat in 2018, introduced species competition with Kincaid's lupine, Hitchcock's blue-eyed grass and other native species should be monitored closely given the observed increases in exotic species cover, particularly exotic graminoid species. Exotic species have potential to outcompete native species by limiting available space, nutrients, and water (Corbin and D'Antonio 2004; D'Antonio and Mahall 1991; Hejda et al. 2009; Melgoza et al. 1990).

Management discussion

Flame weeding

Flame weeding activities at Oak Basin have been focused in areas where Kincaid's lupine is not present, soils tend to be shallower and rockier, and the plant community has more annual, introduced graminoids than in nearby areas occupied by Kincaid's lupine.

A total of three areas have been evaluated for effects of flame weeding, two areas in Meadow A (Patches 3 and 4), and one area in Meadow B (Patch 3). Treatment history for these patches is listed in Appendix A. In summary, areas have been treated 1-3 times with the third treatment a spot treatment to target introduced species and to allow seeded native forbs and graminoids to establish.

In 2015 areas near planned flame weeded patches that had similar soils and vegetation were monitored to be used as comparisons to flame weeded patches. Because the site is undergoing active restoration, untreated areas with similar physical characteristics were not available in the meadows after 2015. Monitoring in 2018 indicates that annual graminoid cover has increased since initial flame weeding treatments in 2015 and 2016. Although we do not have unburned areas for comparison in 2016 and 2018, annual graminoid cover has remained lower than that observed in untreated areas (Figure 14, Figure 15, Figure 16, Figure 17). Untreated areas at Meadow A had 2.5 times higher introduced grass cover than untreated areas at Meadow B (86.5% versus 32.7%). In both 2016 and 2018, the cover of exotic grasses was higher in areas that had not been flame weeded. This was particularly true for exotic, annual species (particularly *Taeniatherum caput-medusae*). Cover of exotic forbs differed little between flame-weeded and untreated areas in all years. Native forb cover in flame-weeded areas varied between meadows and years. At Meadow A, native forb cover was higher in untreated areas, while in Meadow B native forb cover was higher in flame weeded areas (Figure 14, Figure 15, Figure 16). These

measurements will be repeated in the future as management continues in these patches, and additional management actions are implemented (including seeding and outplanting of native species).

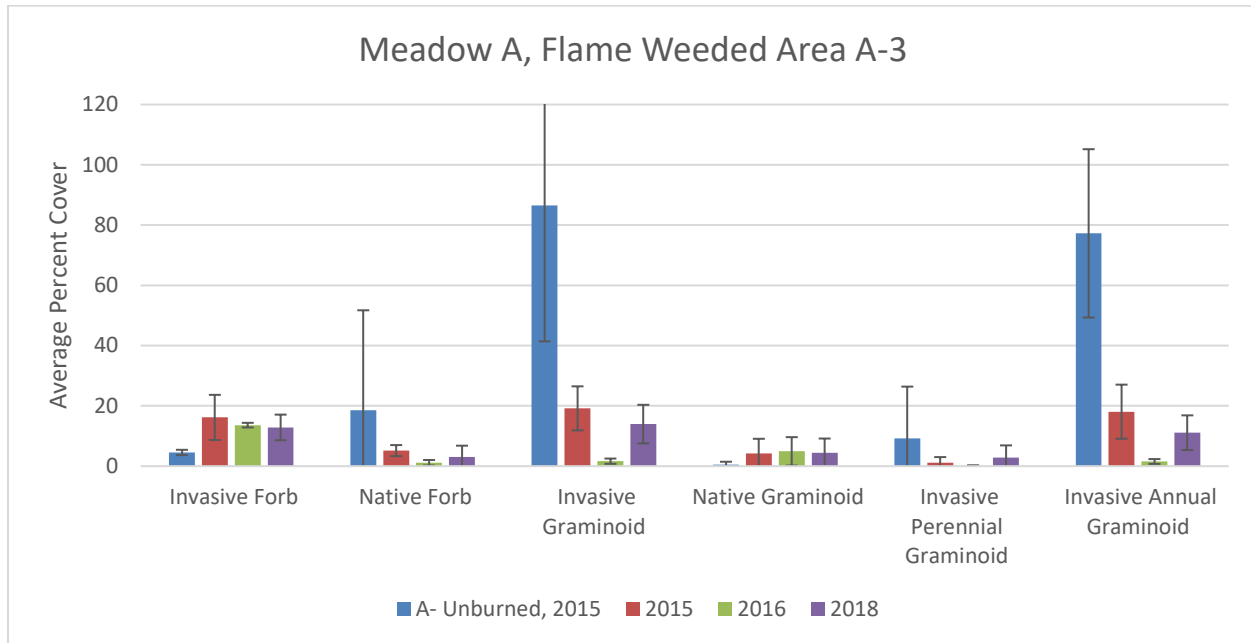


FIGURE 14. PERCENT COVER BY FUNCTIONAL GROUP FOR FLAMEWEEDED AND UNTREATED AREAS IN MEADOW A3. ERROR BARS REPRESENT 95% CI. UNBURNED HABITAT WAS ONLY MONITORED IN 2015 PRIOR TO BURNING.

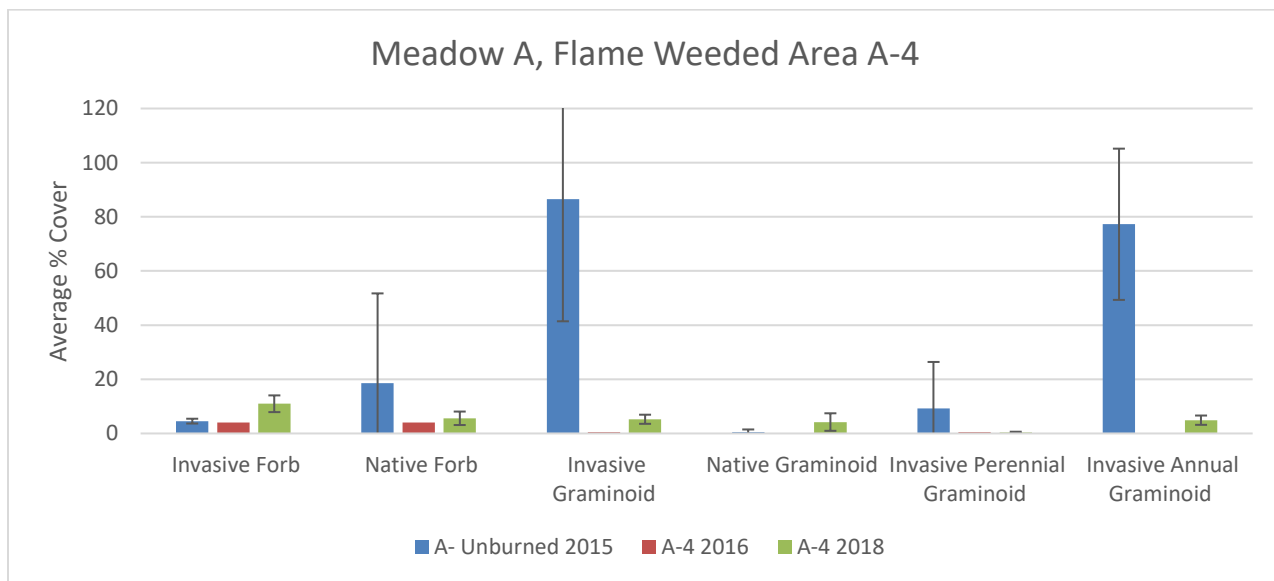


FIGURE 15. AVERAGE PERCENT COVER BY PLANT MANAGEMENT GROUP OF FLAMEWEEDED AND UNTREATED AREAS IN MEADOW B, AT OAK BASIN IN 2016 AND 2018. UNTREATED AREAS WERE NOT MONITORED IN 2018, SEE TEXT FOR DISCUSSION. ERROR BARS REPRESENT 95% CI. N=1 IN 2016, THUS NO ERROR BARS ARE REPORTED.

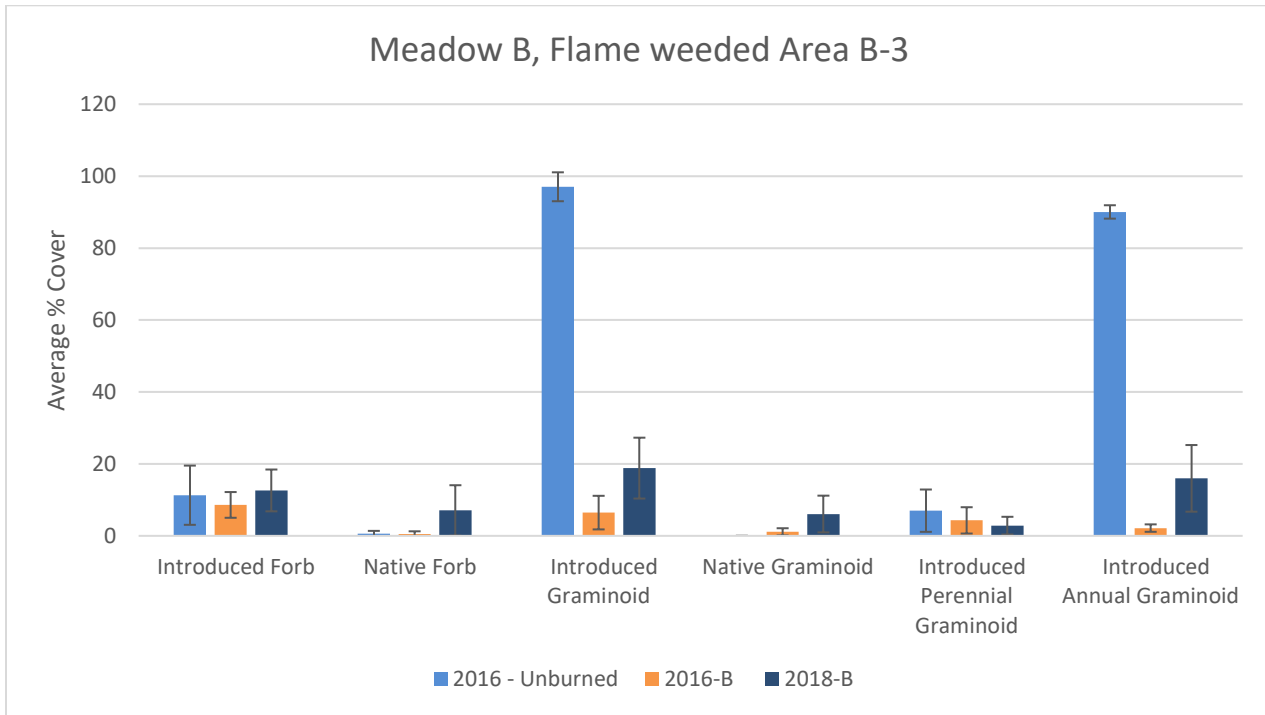


FIGURE 16. AVERAGE PERCENT COVER BY PLANT MANAGEMENT GROUP OF FLAMEWEEDED AND UNTREATED AREAS IN MEADOW B, AT OAK BASIN IN 2016 AND 2018. ERROR BARS REPRESENT 95% CI.



FIGURE 17. PIN FLAGS MARK THE BOUNDARY BETWEEN UNTREATED (LEFT) AND FLAME WEDED IN THE PREVIOUS FALL (RIGHT) IN MEADOW A, PATCH A3, JULY 2015. COVER OF BOTH ANNUAL AND PERENNIAL EXOTIC GRASSES WERE HIGHER IN UNTREATED AREAS.

Mowing

Areas adjacent to existing lupine patches have been mowed in all Meadows since 2012 in an attempt to decrease thatch build up of exotic grasses, particularly *S. arundinaceus*, as well as improve pollinator access to lupine (**Error! Reference source not found.**) (Severns 2008). Monitoring in 2016 and 2018 found little difference in the plant community of mowed and unmowed areas in Meadow A or Meadow B (Figure 18 and Figure 19). Mowing will likely need to continue over time to see any potential impact to targeted species (in this case *L. oreganus* and indirectly the Fender's blue butterfly), however, mowing will only temporarily reduce cover of *S. arundinaceus* and may actually stimulate new vegetative and rhizomatous growth.

Mowing is not recommended as a long-term solution for control of introduced perennial grasses, as many have been selected for traits that allow recovery following defoliation. *Schedonorus arundinaceus* must be consistently mowed to <1.5 inches for control efforts (USDA 2001), which would likely negatively impact the native plant community as well. Grass-specific herbicide application could provide more targeted control, but must be timed to not interfere with the Fender's blue butterfly and meet all necessary permitting requirements.

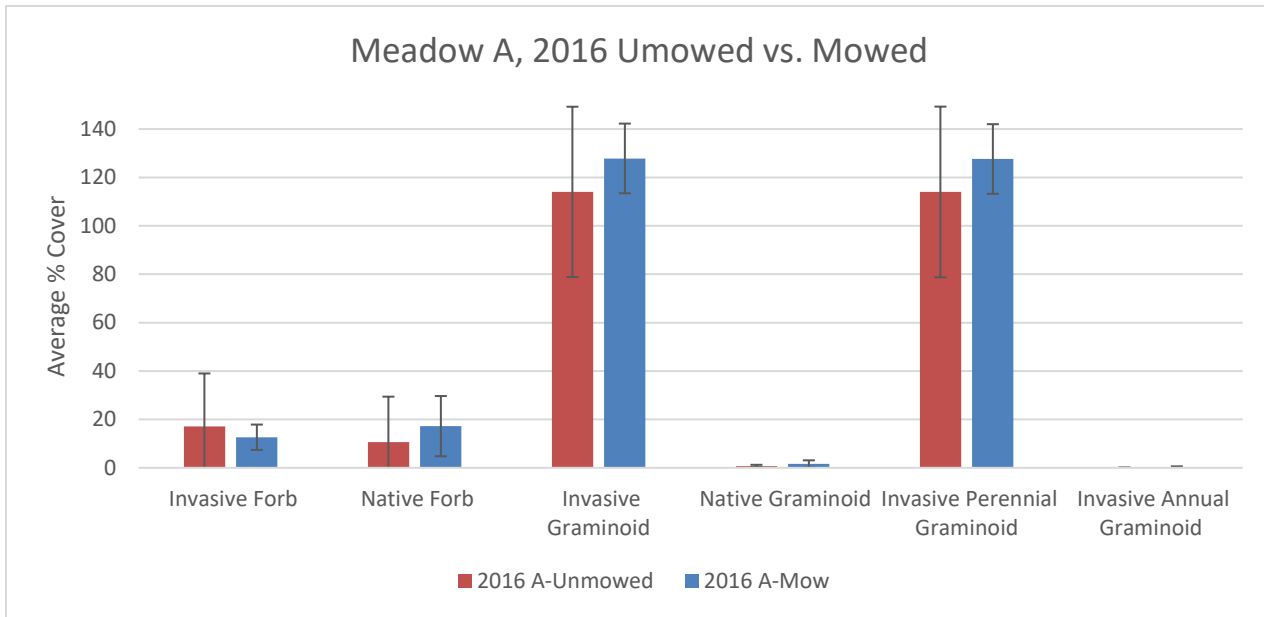


FIGURE 18. NATIVE AND EXOTIC PLANT COVER BY FUNCTIONAL GROUPS IN MOWED AND UNTREATED (“UNMOWED”) AREAS AT OAK BASIN IN 2016 IN MEADOW A. ERROR BARS REPRESENT 95% CI.

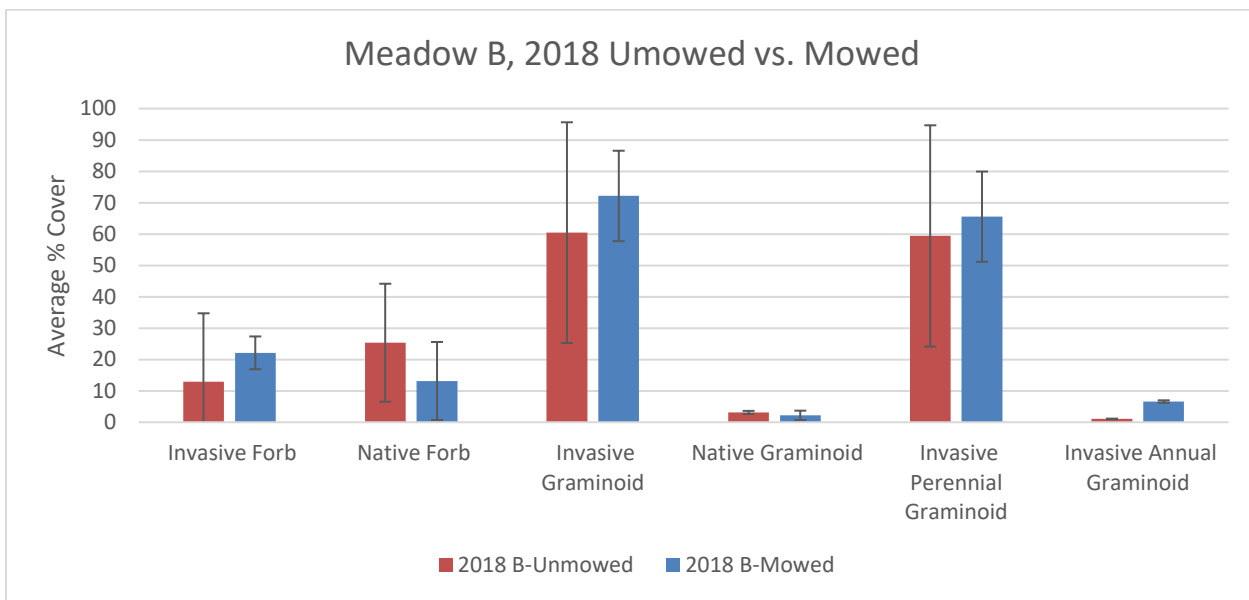


FIGURE 19. PERCENT COVER BY PLANT MANAGEMENT GROUP AT OAK BASIN MEADOW B IN MOWED AND UNTREATED (“UNMOWED”) AREAS. ERROR BARS REPRESENT 95% CI.

Synthesis

The foliar cover and raceme count of Kincaid's lupine has fluctuated periodically since monitoring began in 2006. Inter-annual fluctuations in raceme count and foliar cover highlight the need for ongoing monitoring of extant populations in order to assess the status of these populations. In order to reach recovery goals for this species, continued monitoring of both Kincaid's lupine and the associated plant community will be vital. Since 2012, we have documented a decline in reproductive effort for *S.*

hitchcockii. While both *L. oreganus* and *S. hitchcockii* species increased in 2017 from 2016 values, their populations have either remained the same or declined in 2018. The fluctuations in population dynamics of both of these species during the study is cause for concern and could be due to changes in climate factors observed over recent years, changes in the plant community over time, or other factors not measured here.

The plant community from 2011-2018 has experienced significant changes that could negatively impact the rare species present, in particular Kincaid's lupine. Meadows A and B have experienced increases in introduced grasses from 2011-2018: from 36% to 56% in Meadow A and 42% to 64% in Meadow B. Unlike Meadow A and B and unlike the trend from 2011 to 2018, Meadow C had a large decrease in introduced grasses from 103% in 2017 to 38% in 2018. Reasons for this are unknown. While introduced graminoid cover was lower in 2018 compared to 2017 the prevalence of these introduced grasses in the community is alarming and pose a great challenge for restoration.

MANAGEMENT RECOMMENDATIONS AND CONCLUSIONS

It is recommended that plots A3, B3 and A4 continued to be monitored for native species establishment and introduced species occurrence. These plots should be spot-weeded in 2018 to reduce exotic species occurrence and promote native species establishment from seeding efforts. Plot A4 should receive one more year of flame weeding treatment in the spring and fall of 2019, followed by seeding in the fall of 2019.

Blackberries continue to regrow in *L. oreganus* plots after six previous grubbing efforts (conducted from 2013-2018). Grubbing of blackberry patches in Meadow B, in and near lupine plot 1, will be a necessary management activity in 2019 and beyond, given the extensive root systems and sprouting capability of this introduced shrub. Ideally, this species will be treated with herbicide once this tool becomes available on the BLM-owned portion of Oak Basin. Management activities should also focus on reducing the abundance of introduced graminoids using an alternative to mowing, especially in areas occupied by Kincaid's lupine and *S. hitchcockii*.

The following habitat management and monitoring activities and recovery actions are recommended at Oak Basin to improve habitat for the suite of rare and endangered species present at this site:

- Continue to increase nectar availability for Fender's blue butterfly by augmenting native forb resource plants through seeding and/or plug outplanting.
- Continue to monitor and assess efficacy of management treatments to reduce abundance of introduced species via appropriate weed control measures.
- Remove more trees in corridors between meadows to increase connectivity of meadows for FBB.
- Pending authorization of the use of prescribed fire, initiate fire treatments.
- Pending authorization of use of herbicides, consider implementation of spot applications and post-fire herbicide application.
- Initiate Eugene East Recovery Zone Kincaid's lupine seed production.
- Augment Kincaid's lupine population with transplants or seeds from appropriate seed sources.
- Monitor outplanted Kincaid lupine outplanting at Oak Basin Tree Farm.
- Initiate active restoration of *S. hitchcockii* population in Meadow C.

Continued population monitoring will be essential to document population trends for both species, especially in response to restoration activities occurring on site and to track whether the Kincaid's lupine

population is meeting recovery goals. Targeted community monitoring of areas pre- and post- treatments is used to guide management and restoration treatments.

The Institute for Applied Ecology is working in partnership with the BLM and TNC to coordinate restoration efforts in the area. Ongoing community, Kincaid's lupine, and Hitchcock's blue-eyed grass monitoring will enable us to assess the effects and success of ongoing restoration at the site.

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APPENDIX A: SUMMARY OF RESTORATION ACTIVITIES AT UPPER OAK BASIN (2012-2018)

2012

- Site inspection and partner coordination.

2013

- Site inspection and partner coordination.
- Mapped *Taeniatherum caput-medusae* (medusahead) locations.
- Mowed around perimeter of all lupine patches and inside 1/3 of all lupine patches.
- Mowed all major *R. bifrons* patches.
- Grubbed several *R. bifrons* patches.
- Flame weeded patches for *T. caput-medusae* control and site preparation for planting/seeding.

2014

- Site inspection and partner coordination.
- Flame weeded patches for medusahead control and site preparation for planting/seeding.
- Planted 882 bulbs plus 2 15"x15" trays of *Allium amplexans*, 784 rhizomes of *Iris tenax*, 670 plugs of *Eriophyllum lanatum*, and 8 *Balsamorhiza heltzeri* plants.
- Seeded 7.14 lbs *Bromus carinatus*, 4.83 lbs *Elymus glaucus*, 1.27 lbs *Elymus trachycaulis*, 0.50 lbs *Eriophyllum lanatum*, 1.50 lbs *Festuca roemerii*, 0.70 lbs *Plectritis congesta*, 1.14 lbs *Prunella vulgaris* var. *lanceolata*, 1.71 lbs *Sidalcea malviflora* ssp. *virgata*.
- Nectar plant availability assessment.
- Hand weeded of *Cirsium vulgare* and *Cytisus scoparius*.
- Mowed 1/3 of all lupine patches and some *R. bifrons* patches.
- Grubbed *R. bifrons*.

2015

- Site inspection and partner coordination.
- Grubbed of *R. bifrons*.
- Removed small diameter conifer around perimeter of meadows.
- Removed, limbed or girdled trees around edges of meadows and in corridors between meadows. Similar work also done on adjacent Merzenich property.
- Flame weeded patches for medusahead control and site preparation for planting/seeding.
- Planted native plugs: 280 *Danthonia californica*, 100 *Elymus trachycaulis*, 150 *Festuca californica*, 200 *Festuca roemerii*, 1200 *Geranium oreganum*, 2000 *Iris tenax*, 120 *Lomatium dissectum* and 5600 *Sidalcea malviflora* ssp. *virgata*.
- Seeded 3.15 lbs *Danthonia californica*, 1.5 lbs *Eriophyllum lanatum*, 9.40 lbs *Festuca californica*, 6.0 *Festuca roemerii*, 3.0 lbs *Prunella vulgaris* var. *lanceolata* and 3.0 lbs. *Sidalcea malviflora* ssp. *virgata*.
- Mowed 1/3 of all lupine patches.

2016

- Site inspection and partner coordination.

- Flame weeded medusahead control and site preparation for planting/seeding.
- Grubbed *R. bifrons*.
- Removed small diameter conifer around perimeter of meadows.
- Hand weeded *Cytisus scoparius*.
- Mowed 1/3 of all lupine patches.
- Planted plugs: 40 *Danthonia californica*, 50 *Iris tenax* and 400 *Sidalcea malviflora* ssp. *virgata*.

2017

- Site inspection and partner coordination.
- Outplanted 68 plugs of *Lupinus oreganus* on neighboring private land, Oak Basin Tree Farm.
- Flame weeded patches for medusahead control and site preparation for seeding.
- Grubbed *R. bifrons*.
- Seeded *Danthonia californica* 2.37 lbs, *Elymus trachycaulis* 2.0 lbs, *Eriophyllum lanatum* 1.28 lbs, *Festuca roemerii* 3.41 lbs, *Plectritis congesta* 1.18 lbs, *Prunella vulgaris* var. *lanceolata* 0.75 lbs and *Sidalcea malviflora* spp. *virgata* 1.0 lbs.
- Mowed approximately one-third of lupine patches after senescence of *L. oreganus*.
- Hand mowed flame weeded plots A3, A4, B3 and B4 in Meadows A and B.

2018

- Site inspection and partner coordination.
- Monitored 38 outplanted plugs of *Lupinus oreganus* on neighboring private land, Oak Basin Tree Farm; 18 survived.
- Flame weeded patches for medusahead control and site preparation for seeding in Meadows A and B.
- Grubbed *R. bifrons*.
- Pulled Scotch broom Italian thistle, and shining geranium (geranium pulled near lupine patch 460 in Meadow A only)
- Cut seedlings and saplings from edges of all meadows. It was particularly concentrated in Meadow C.
- Mowed approximately one-third of lupine patches after senescence of *L. oreganus*.
- Seeded flame weeded areas (~0.67 acres) with a native forb and grass mix: *Danthonia californica* (1.87), *Elymus glaucus* (1.45), *Eriophyllum lanatum* (0.28), *Koeleria micrantha* (0.09), *Plectritis congesta* (0.46), *Prunella vulgaris* (0.38), and *Wyethia angustifolium* (3.27)

APPENDIX B: LUPINE COVER AND RACEME COUNTS BY PLOT FROM 2013-2018. SHADED CELLS INDICATE WHICH PLOTS WERE MOWED IN THE PRECEDING FALL.

	2013 Cover (m ²)	Mature Racemes	2014 Cover (m ²)	Mature Racemes	2015 Cover (m ²)	Mature Racemes	2016 Cover (m ²)	Mature Racemes	2017 Cover (m ²)	Mature Racemes	2018 Cover (m ²)	Mature Racemes
Meadow A	42.9	71	80.4	1108	49.2	129	47.3	209	87.5	1996	110.3	1984
7	1.1	10	2.9	36	1.8	10	1.9	12	2.8	201	1.8	62
8	0.3	3	0.2	1	0.1	0	0.1	0	0.3	4	0.4	6
9	4.7	2	6.4	146	3.2	24	2.2	5	4.7	49	6.0	30
10	0.4	0	0.8	18	0.4	3	0.6	0	0.5	8	0.6	3
369											10.9	50
406	0.7	1	0.3	0	0.0	0	0.1	2	0.3	1	0.4	0
450	10.8	23	11.3	30	7.5	21	3.9	22	6.2	29	7.4	7
451	0.7	0	1.6	4	0.6	0	0.9	0	1.4	16	1.4	0
452	3.4	6	10.0	93	8.5	9	3.8	0	11.1	129	10.4	34
454	1.8	4	5.7	10	2.6	0	1.3	0	6.8	36	6.4	3
459	9.7	6	19.3	361	11.9	9	16.8	0	26.3	1069	39.3	669
460	2.4	2	4.8	192	3.0	12	2.5	117	6.5	206	6.4	785
464	5.3	4	13.8	118	6.4	2	7.9	0	17.4	126	12.0	23
509	1.0	8	1.5	52	1.6	30	0.7	51	2.3	56	5.0	239
510	0.3	0	1.4	14	1.3	4	0.0	0	0.1	1	0.8	8
511	0.4	2	0.5	33	0.3	5	4.5	0	0.8	65	1.2	65
Meadow B	25.5	122	51.6	627	21.4	120	18.9	197	34.7	736	27.9	587
1	8.6	20	31.3	309	11.8	31	8.8	43	23.2	441	12.1	379
2	0.5	1	0.5	1	0.1	1	0.0	0	0.1	3	0.0	1
3	2.0	5	3.2	21	1.6	7	1.5	13	1.3	15	0.5	5
4	1.7	2	2.5	23	0.7	7	0.9	0	1.5	40	0.4	2
5	4.3	2	6.2	114	4.3	50	1.7	25	1.6	19	4.5	22
6	3.6	51	4.6	125	2.9	24	2.3	21	2.5	51	4.3	107
399	4.9	41	3.3	34	0.0		3.7	95	4.6	167	6.1	71
Meadow C	11.2	44	17.8	311	21.7	177	14.0	217	29.5	881	25.2	471
400	0.126	0	0.1142	1	0.0385	1	0.0406	3	0.0478	0	0.0926	0

	2013		2014		2015		2016		2017		2018	
	Cover (m²)	Mature Racemes	Cover (m²)	Mature Racemes	Cover (m²)	Mature Racemes	Cover (m²)	Mature Racemes	Cover (m²)	Mature Racemes	Cover (m²)	Mature Racemes
431	1.782	0	2.7392	20	3.1259	8	1.5526	0	3.8819	62	2.644	32
432	5.0704	42	10.132	173	9.3643	86	7.4113	187	12.243	408	12.432	322
433	4.1722	2	4.8172	117	9.0752	82	4.2815	14	12.341	408	8.6652	78
594							0.7351	13	0.866	1	1.2694	38

APPENDIX C. AERIAL PHOTOS AND PLOT DIAGRAMS OF OAK BASIN.

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AERIAL PHOTO WITH AN OVERVIEW OF THE OAK BASIN STUDY AREA, INCLUDING MEADOW NAMES. DETAILED MAPS OF EACH MEADOW AND PLOT NUMBERS FROM OUR STUDY ARE INCLUDED BELOW.

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AERIAL PHOTO OF THE THREE MEADOWS AT OAK BASIN THAT CONTAIN PATCHES OF KINCAID'S LUPINE. PLOT NUMBERS AND MEADOW NAMES ARE INDICATED.

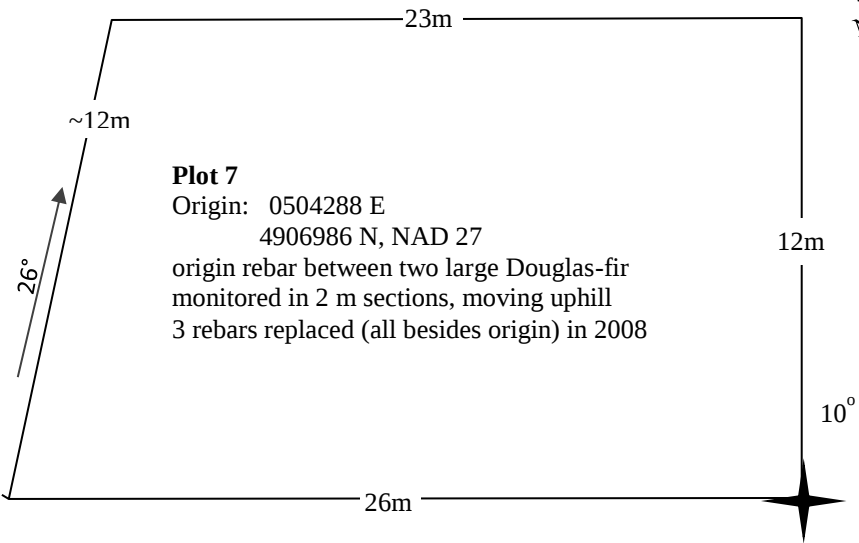
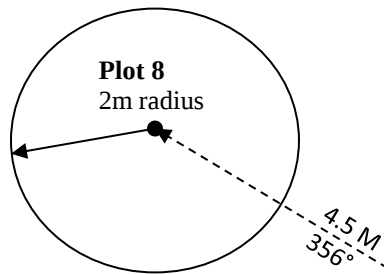
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DIAGRAMS OF KINCAID'S LUPINE MONITORING PLOTS AT OAK BASIN MEADOW A.

Meadow A

Plot 8

Rebar 4.5m to NW (356°) from
plot 7, tree has fallen across plot
Origin: 0504259 E
4907001 N; NAD 27



Plot 7

Origin: 0504288 E
4906986 N, NAD 27
origin rebar between two large Douglas-fir
monitored in 2 m sections, moving uphill
3 rebars replaced (all besides origin) in 2008

Tree

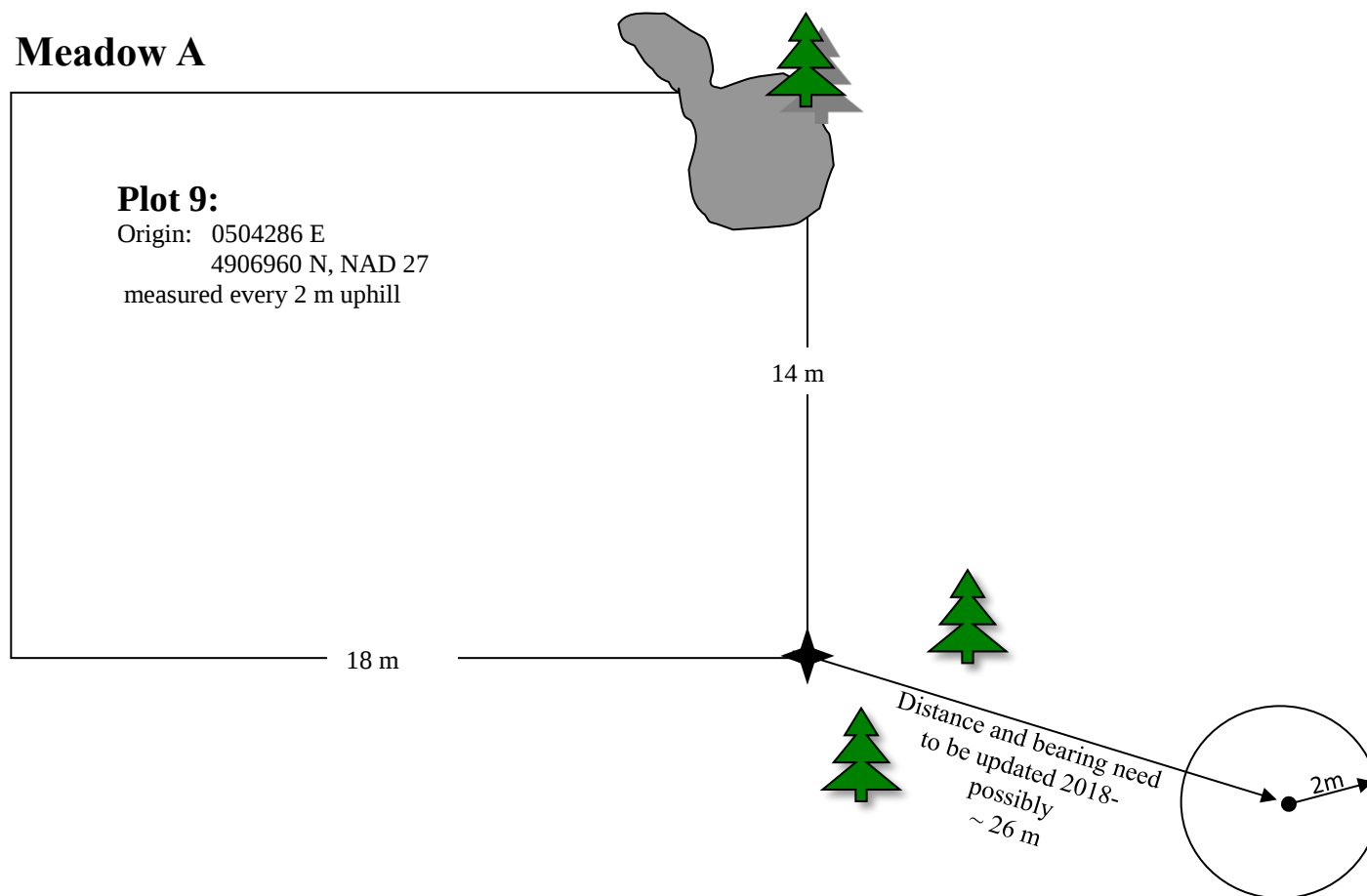
Tree

Unrelated rebar

Meadow A

Plot 9:

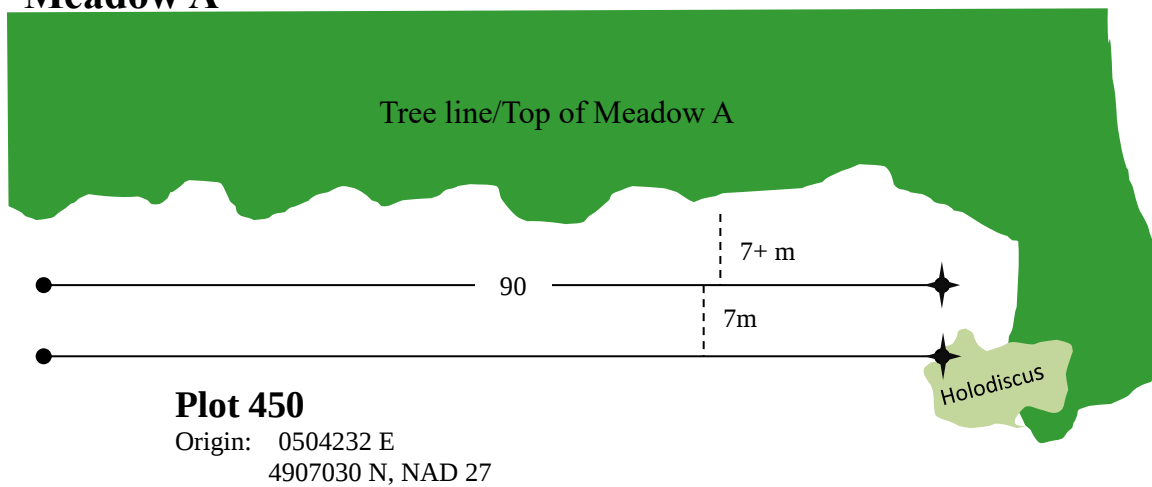
Origin: 0504286 E
4906960 N, NAD 27
measured every 2 m uphill



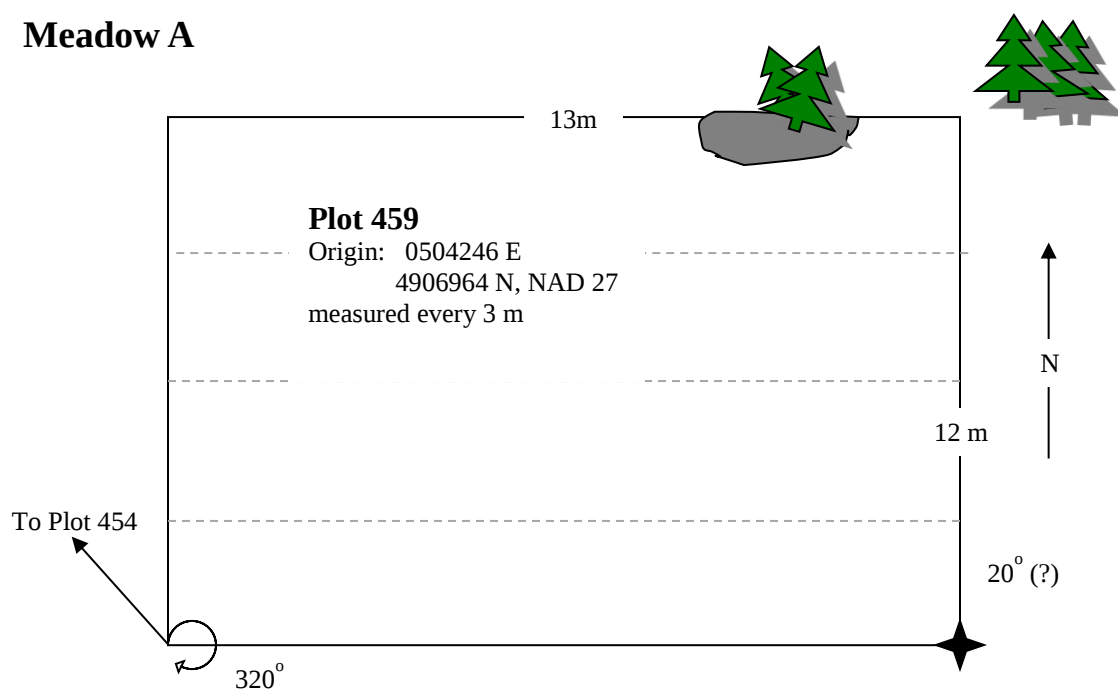
Plot 10: 2m radius

Origin: 0504312 E
4906952 N, NAD 27
From plot 9 Origin walk south east
through small "neck" towards tree
line

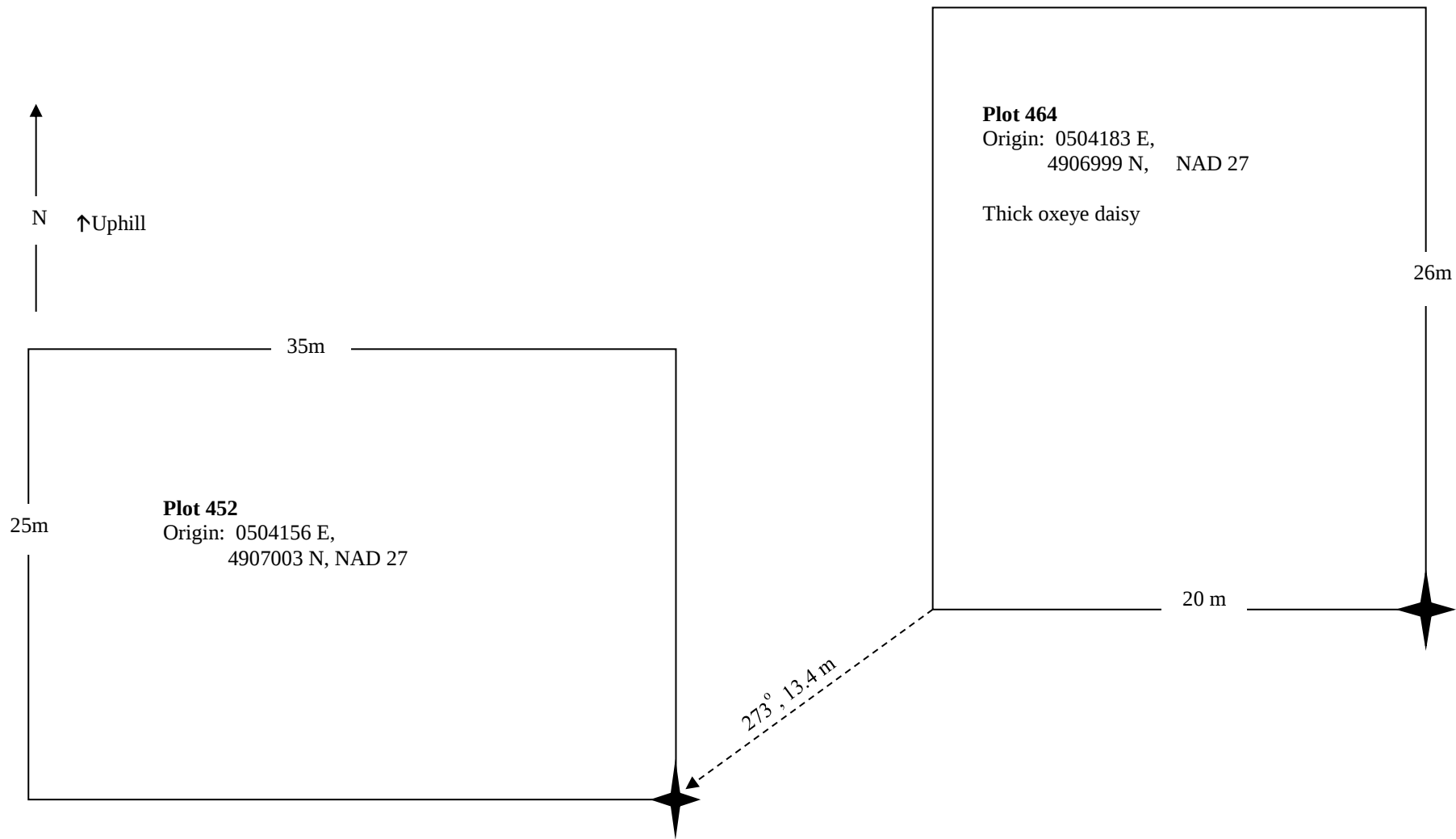
Meadow A



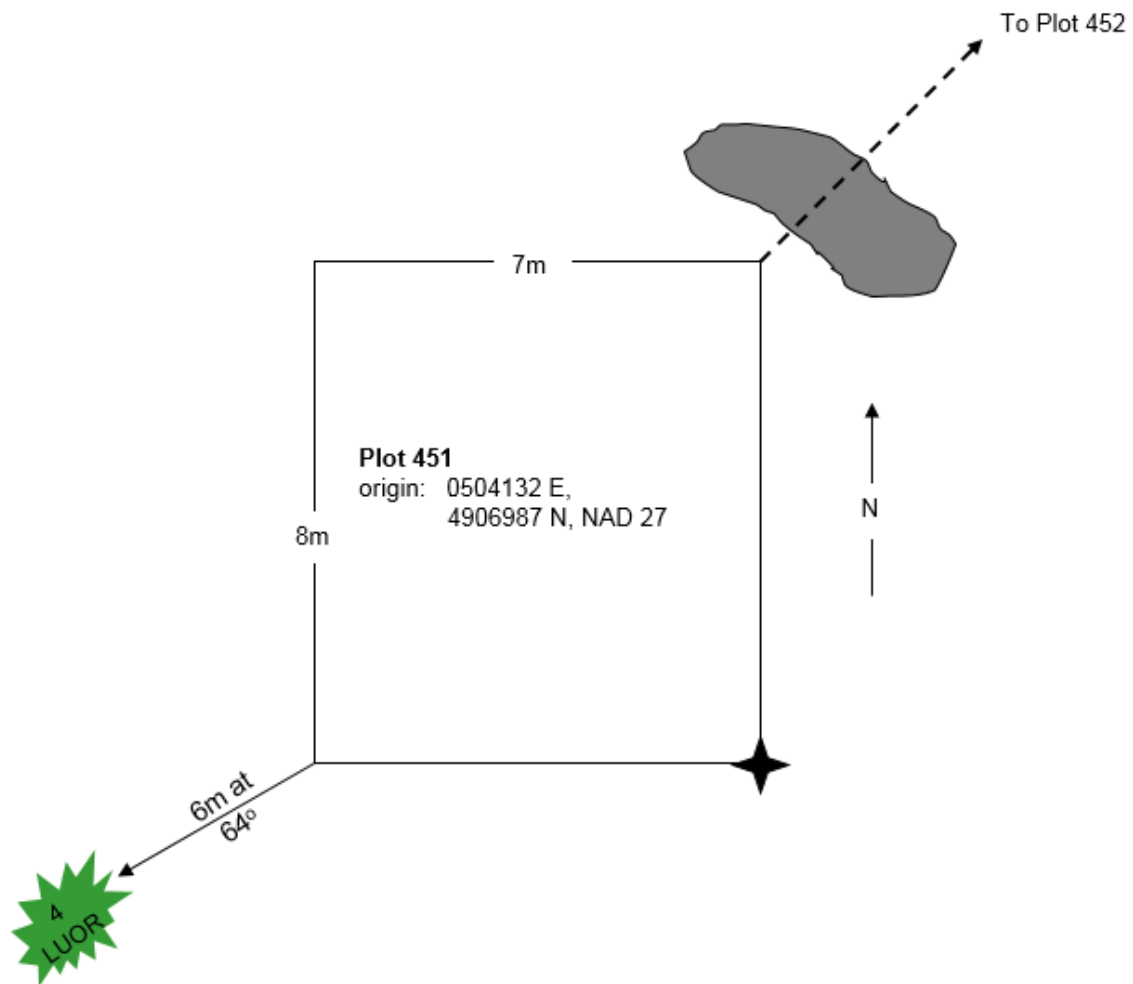
Meadow A



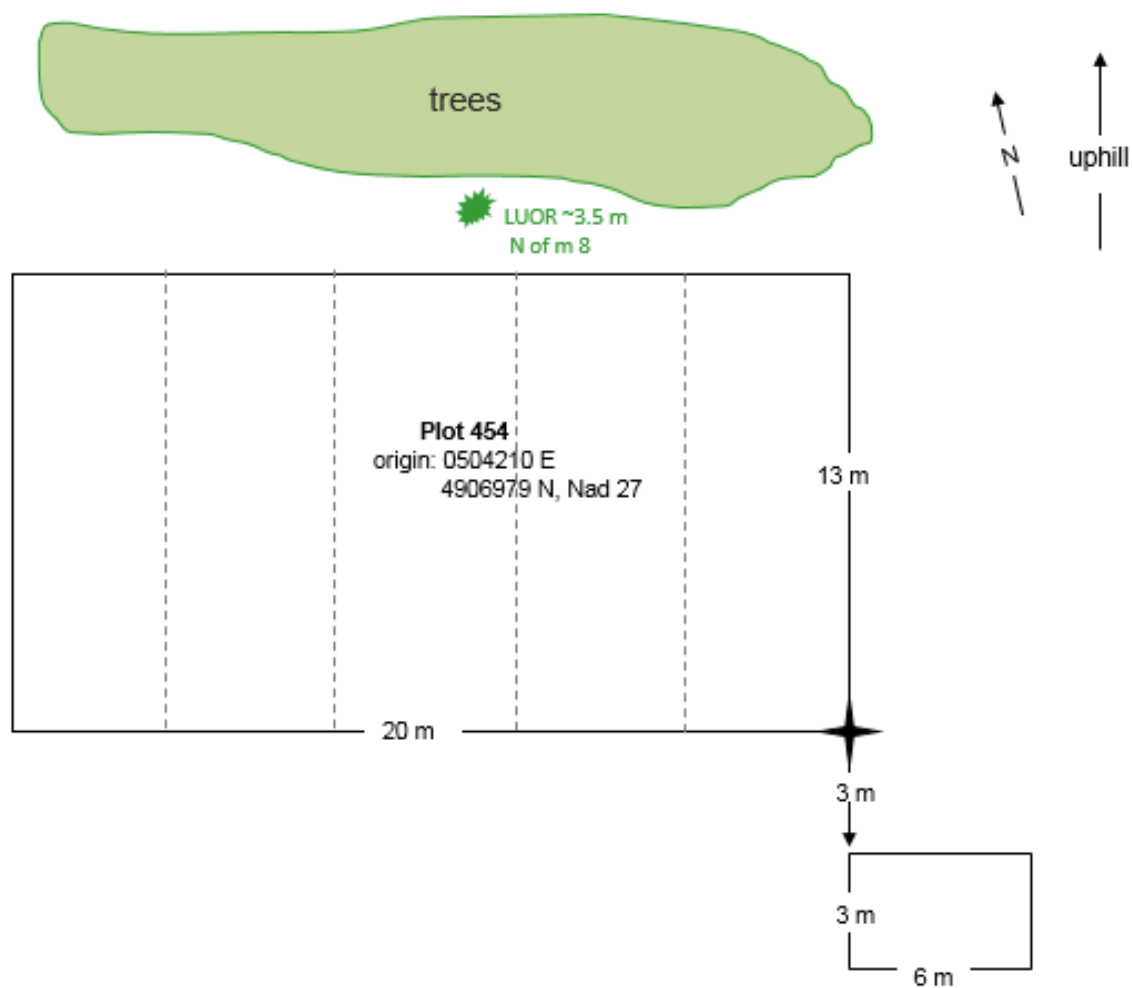
Meadow A



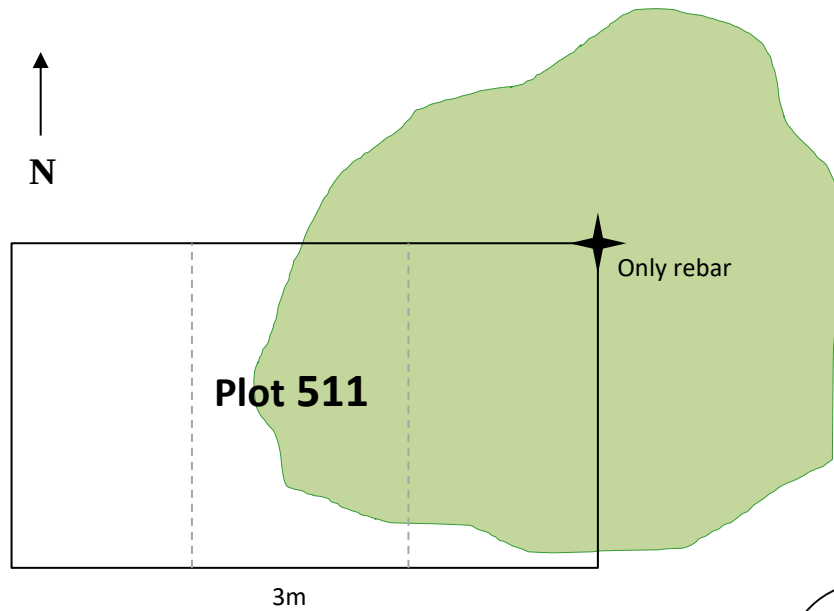
Meadow A



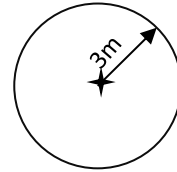
Meadow A

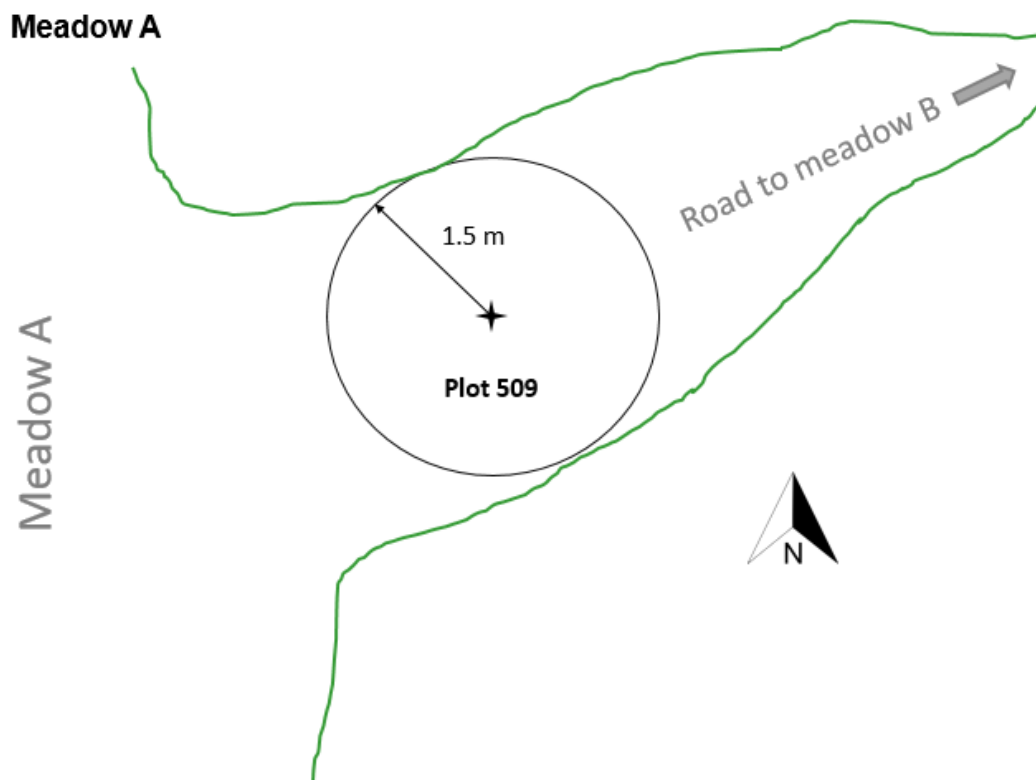


Meadow A

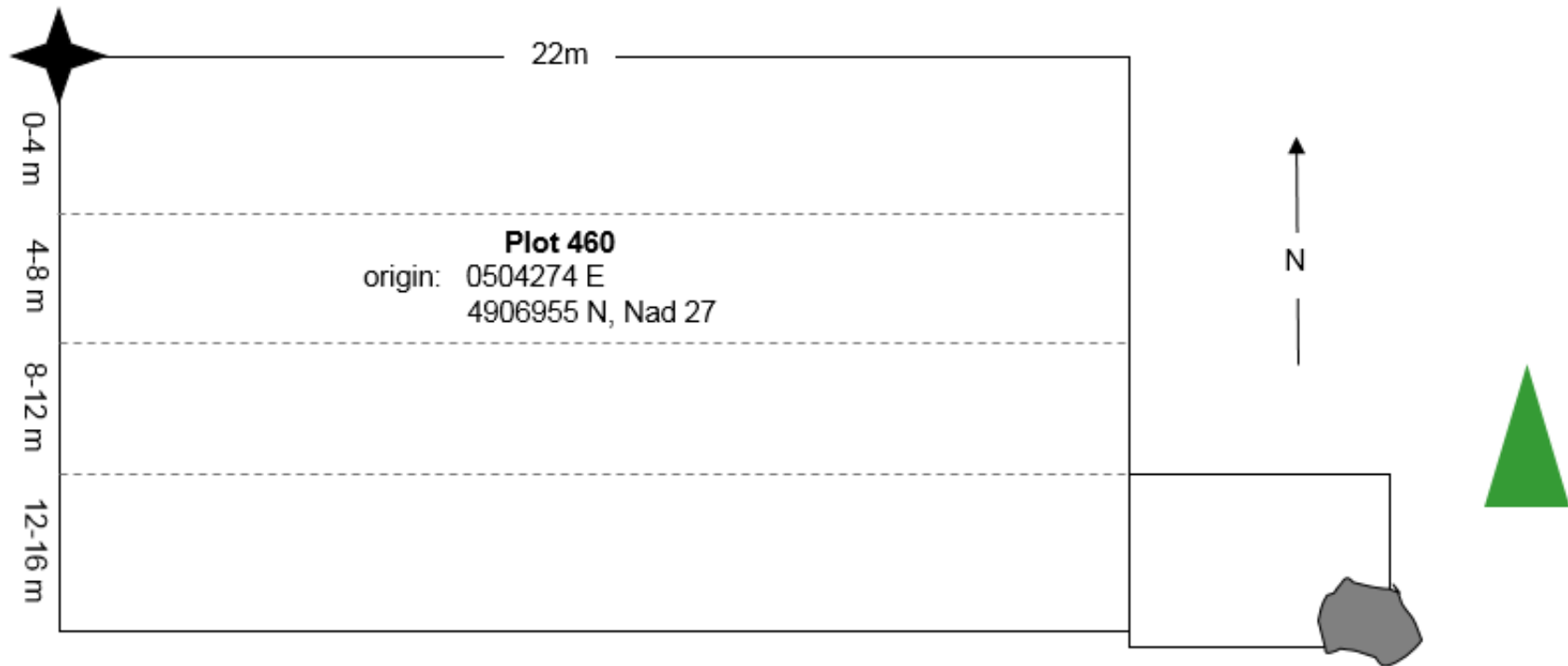


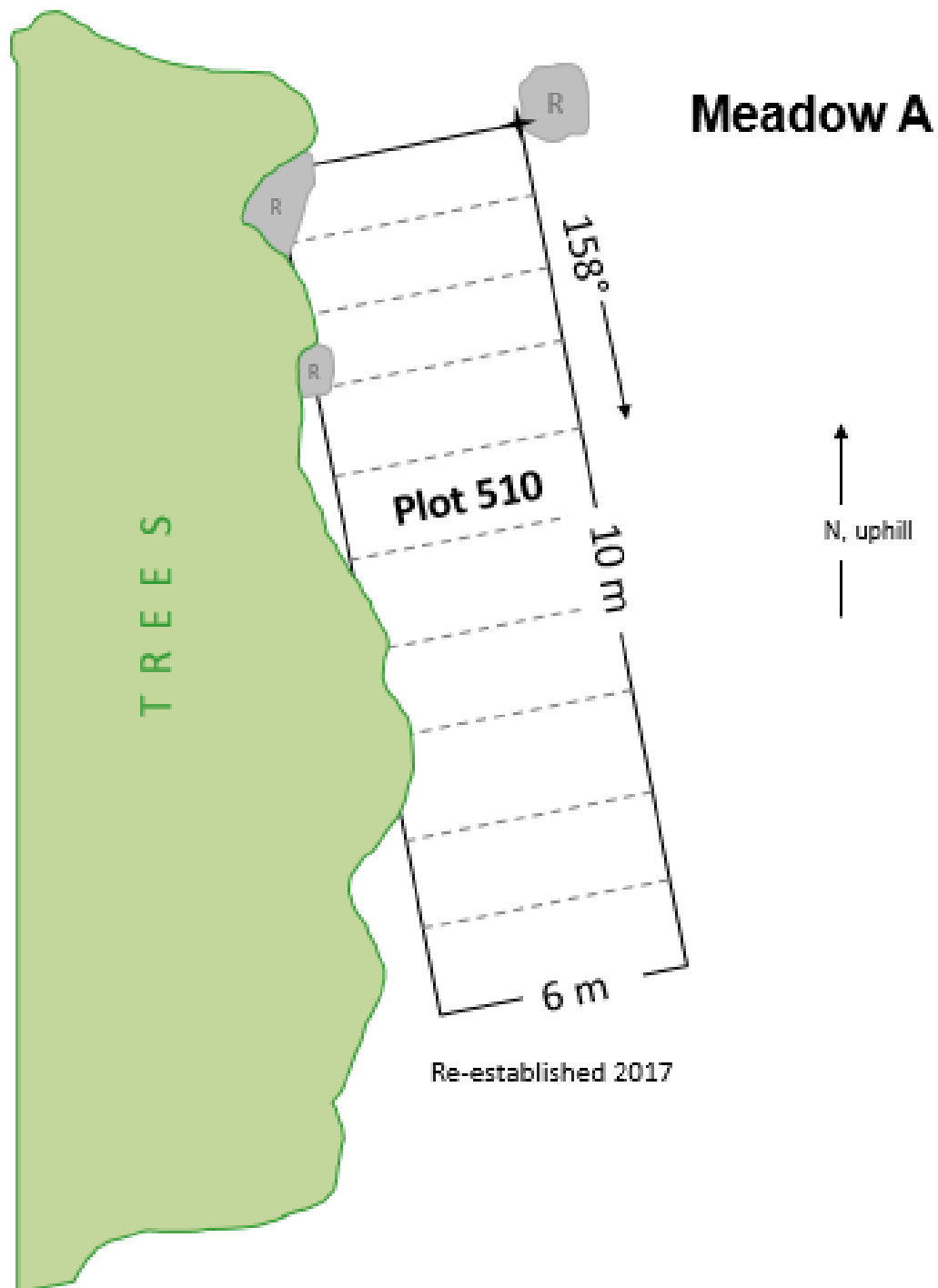
Plot 511 as established in 2011 (3 x 0.5 meter belt transect) no longer encompasses population. Left map shows the plot as monitored in 2017: 3 m x 1m with the origin in the NE corner (monitored this way to correlate with data sheet). Suggest creating new data sheets and re-establishing in 2018 as a 3m radius plot with the rebar in the center:



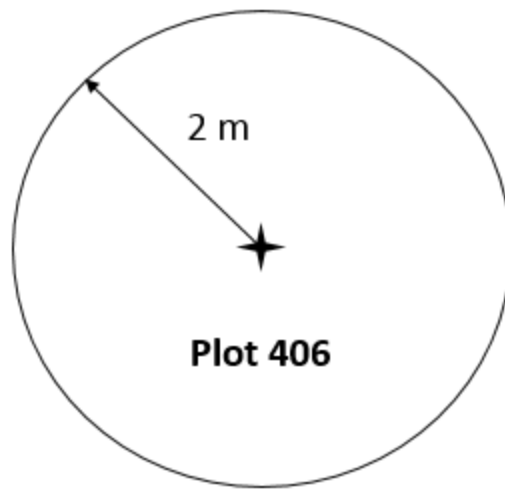


Meadow A





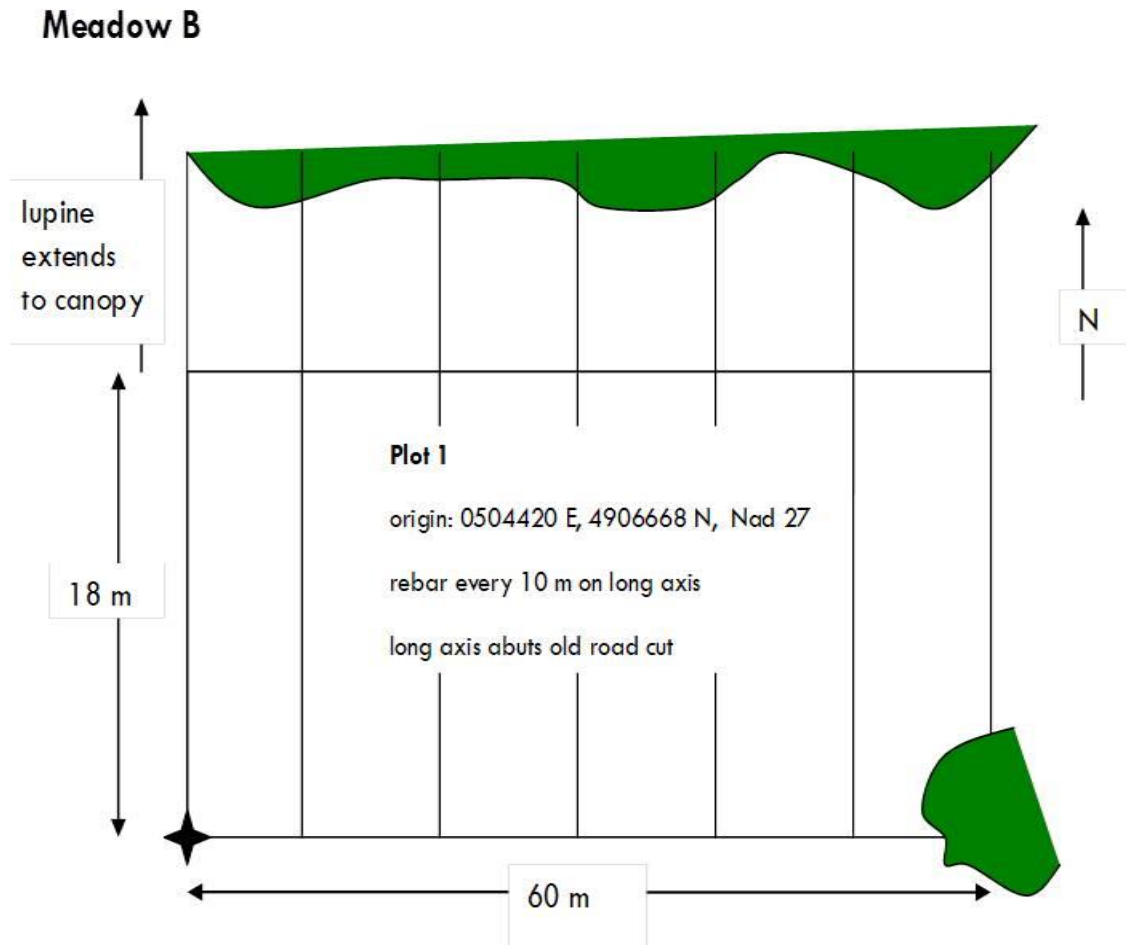
Meadow A



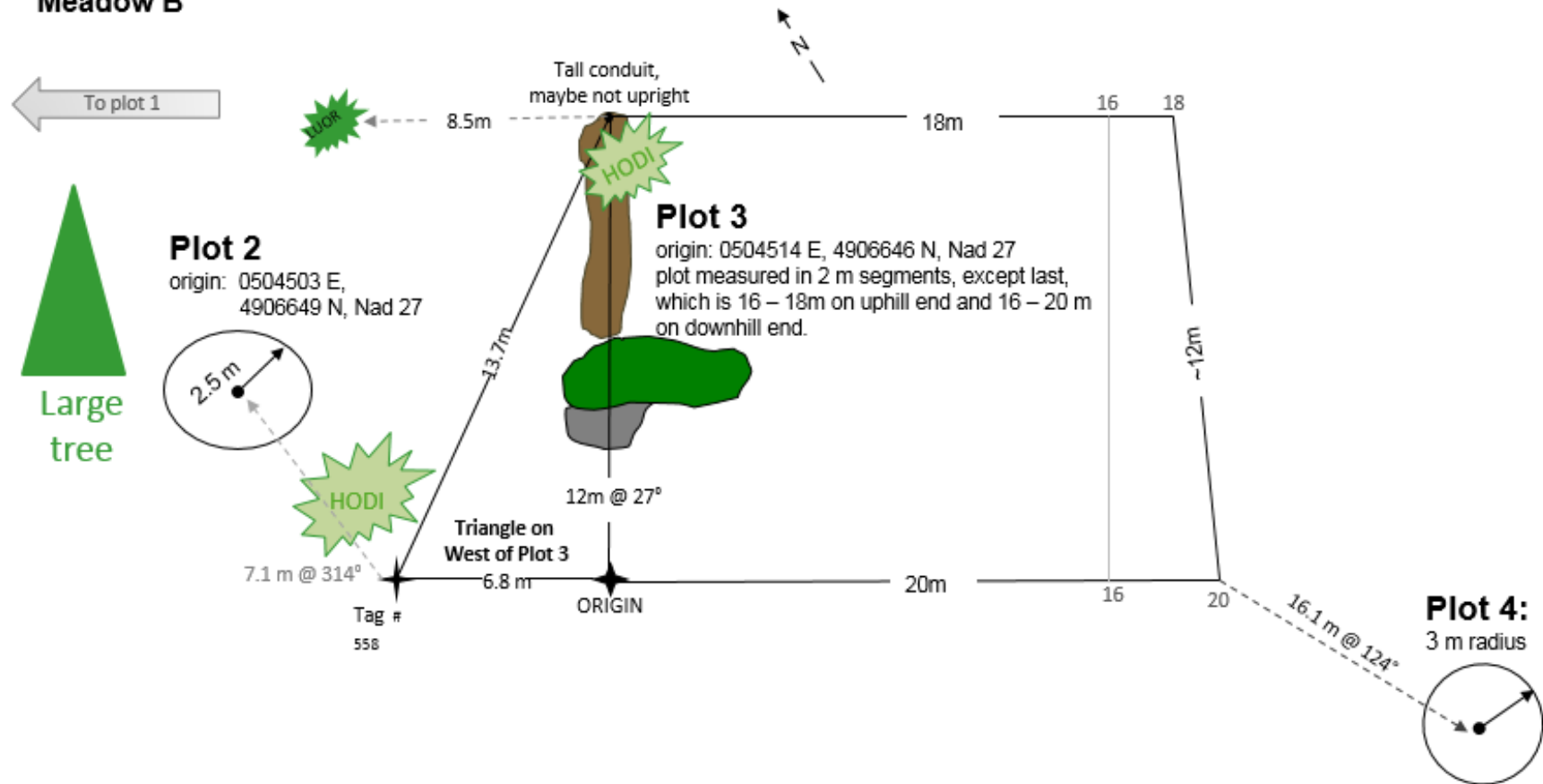
NW of Plot 450

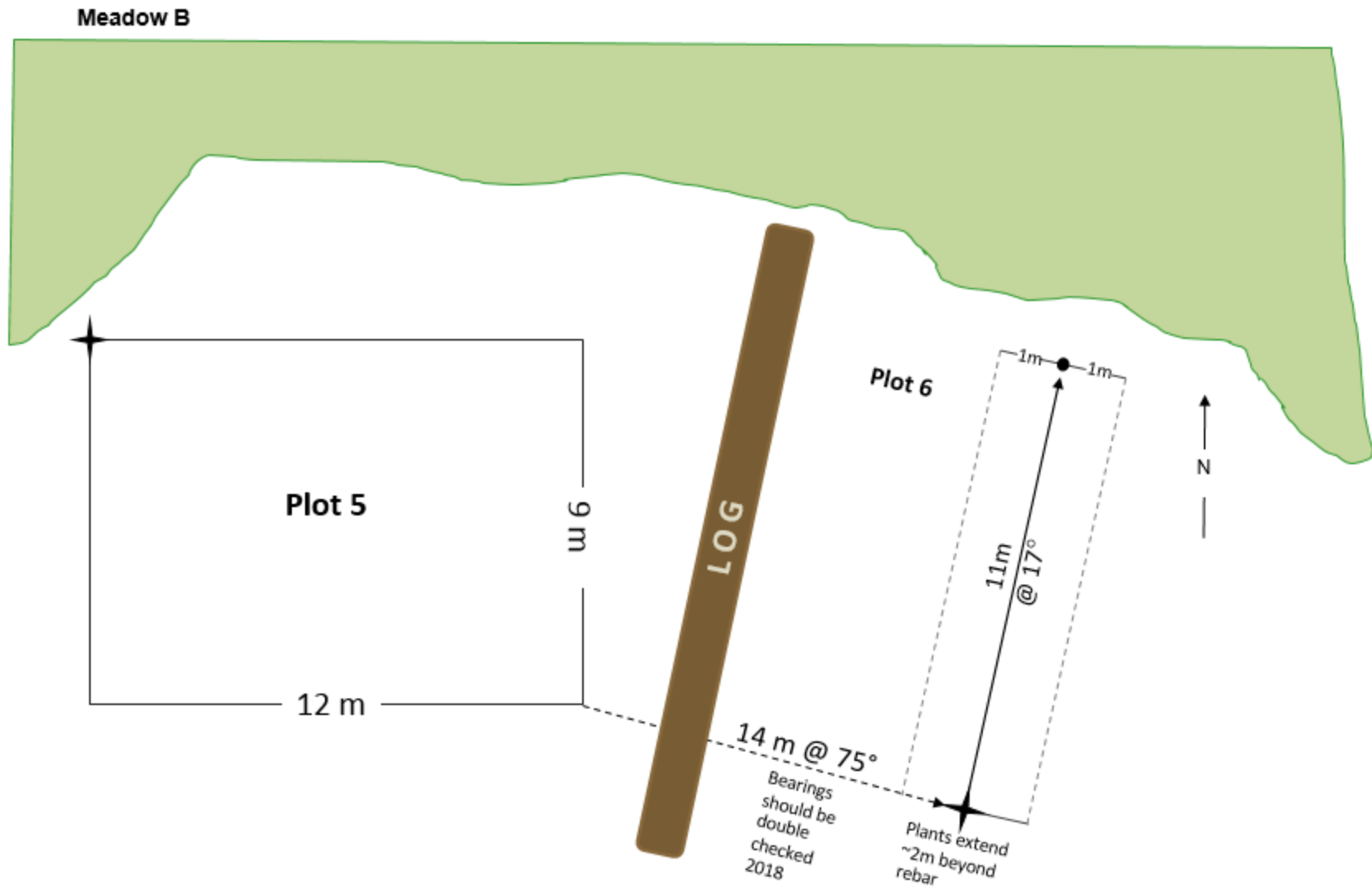
Image removed from web version

OVERVIEW OF PLOTS IN MEADOWS B AND C.



Meadow B





Meadow C

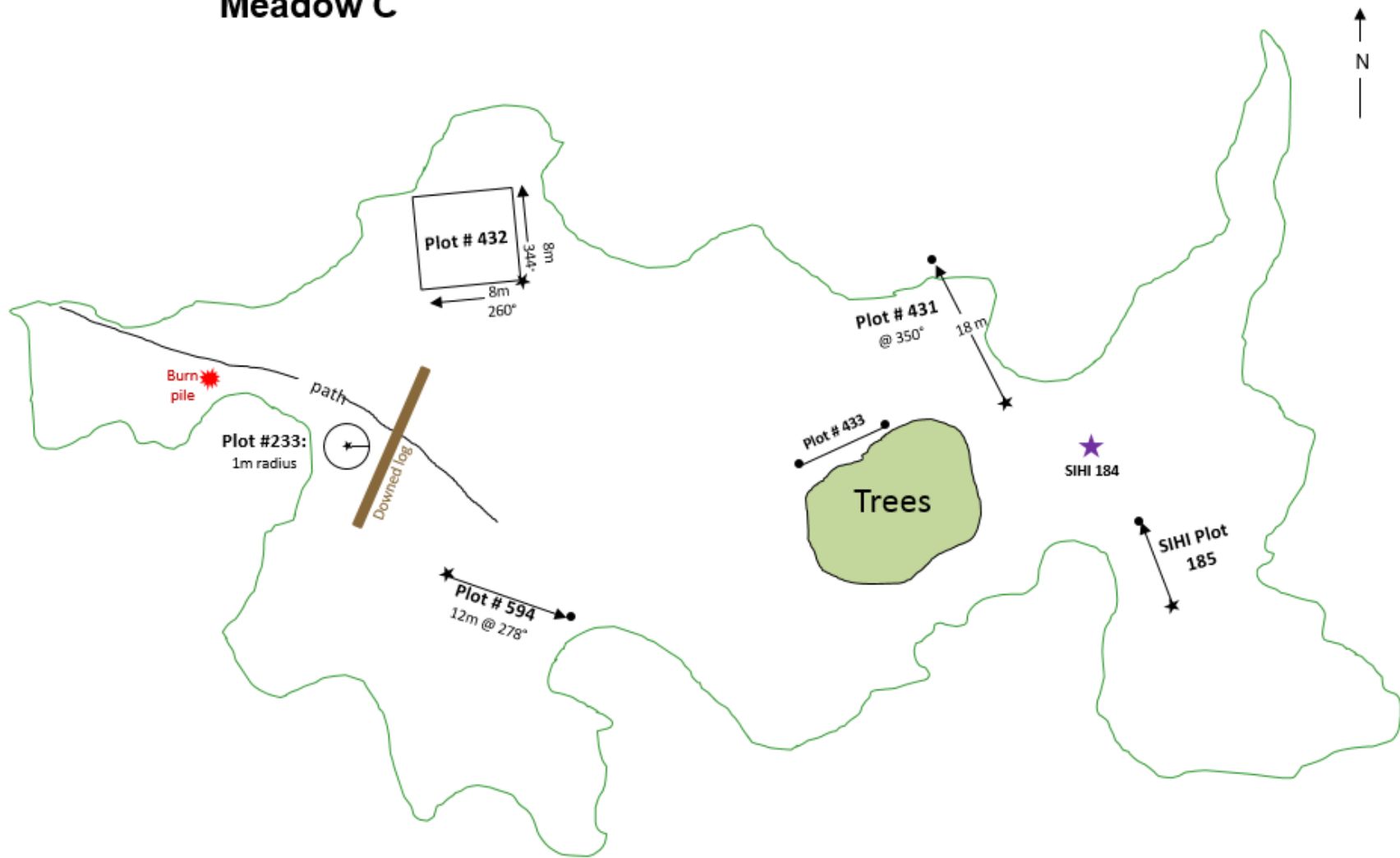
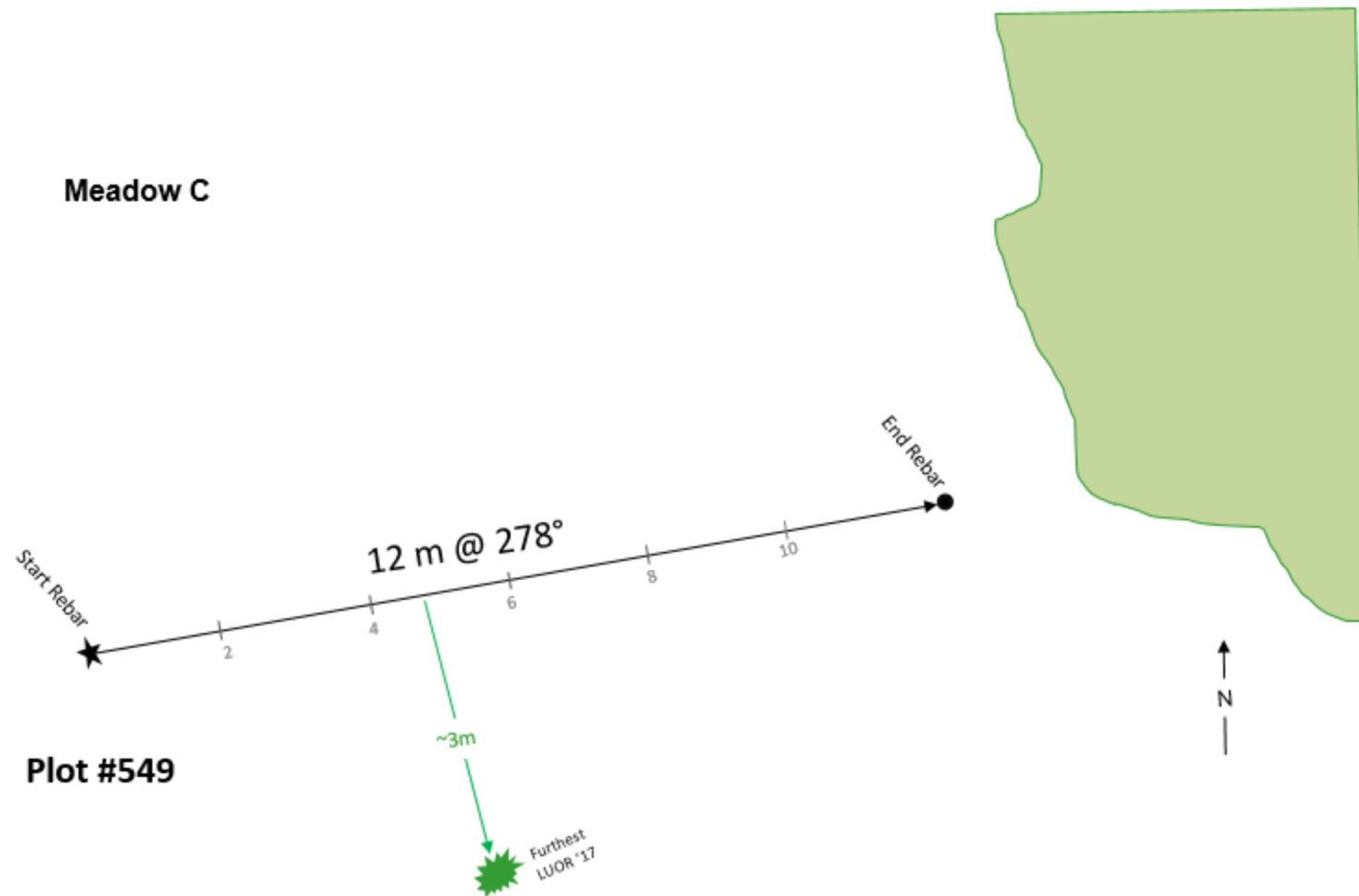


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APPENDIX D. LOCATION, DIMENSIONS, AND MONITORING NOTES FOR KINCAID'S LUPINE AND HITCHCOCK'S BLUE-EYED GRASS (SIHL; IN BOLD) PLOTS AT OAK BASIN.

Meadow	Plot Number	Dimensions	origin (Nad27)	Notes
A	7	23m x 12m	504288 E 4906986 N	measured in 2m increments
A	8	Circular, 2m radius	504259 E 4907001 N	fallen tree covering part of plot
A	9	18m x 14m	504286 E 4906960 N	measured in 2m increments
A	10	Circular, 2m radius	504312 E 4906952 N	
A	459	13m x 12m	504246 E 4906964 N	measured in 3m increments
A	454	20m x 13m	504210 E 4906979 N	3 individuals 8m and 48° from origin
A	464	20m x 26m	504183 E 4906999 N	measured in 2m increments
A	450	90m x 7m	504232 E 4907030 N	measured in 5m increments
A	451	8m x 7m	504132 E 4906987 N	measured in 2m increments
A	452	25m x 35m	504156 E 4907003 N	measured in 2m increments
A	460	22m x 16m with extension	504274 E 4906955 N	measured in 4m increments
A	406	Circular, 2m radius	504101 E 4907056 N	
A	509	Circular, 1.5m radius	504199 E ¹ 4907048N ¹	new in 2011
A	510	8m x 6m	503967 E ¹ 4907105 N ¹	new in 2011, measured in 1m increments N-S
A	511	3m x 1m	504702 E ¹ 4907160 N ¹	new in 2011, measured in 1m segments N-S
B	1	60m x 18m+	504420 E 4906668 N	measured in 5m increments
B	2	Circular, 2.5m radius	504503 E 4906649 N	

Meadow	Plot Number	Dimensions	origin (Nad27)	Notes
B	3	12m x 18m (20m)	504514 E 4906646 N	measured in 2m increments
B	4	Circular, 3m radius	504545 E 4906630 N	
B	5	12m x 9m	504597 E 4906570 N	measured in 2m increments
B	6	11m belt transect	504628 E 4906559 N	measured 2m to each side
B	399**	11m belt transect	504326 E 4906806 N	measured to E and W, in 1-2m increments.
B	558	2m radius	504413 E ¹ 4906842 N ¹	new in 2014
C	594	12m belt	See map	New in 2017
C	233	1m radius	See map	New in 2017
C	1(185)²	15m x 4m	504639 E¹ 49065659N¹	measured in 1m increments
C	2 (186)²	2m radius	504655 E¹ 4906555N¹	divided into NW, NE, SW, and SE sections
C	433	8m belt transect	504712 E 4906379 N	measured to E and W, in 2m increments
C	432	8m x 9m	504649 E 4906401 N	measured in 2m increments
C	431	18m belt transect	504732 E 4906378 N	measured to N and S, in 1m increments
C	400	1m radius	504609 E ¹ 4906553 N ¹	new in 2012; along tree line in <i>Rupertia physodes</i>

¹ Coordinates are in NAD83 instead of NAD27.

² Plots 1 (185) and Plot 2 (186) in Meadow C are SIHI plots.

** There is a large patch of lupine on the SW end of Meadow B which is on private property. Plot 399 captures the lupine nearest the public/private boundary.

APPENDIX E. LOCATIONS OF KINCAID'S LUPINE PLANTINGS (ORANGE POLYGONS PLANTED IN 2017) ON MERZENICH PROPERTY. SURVIVORSHIP OF TRANSPLANTS WAS MONITORED IN 2018.

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APPENDIX F. TOTAL NUMBER OF MATURE RACEMES AND PERCENT OF RACEMES ABORTED OF KINCAID'S LUPINE, AND TOTAL LUPINE COVER AND NUMBER OF RACEMES PER M² OF LUPINE FOLIAR COVER AT OAK BASIN FROM 2006-2018.

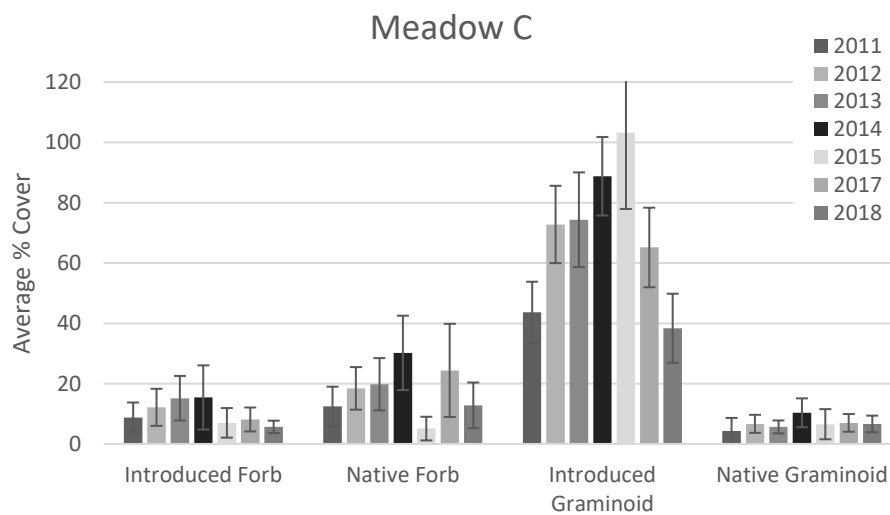
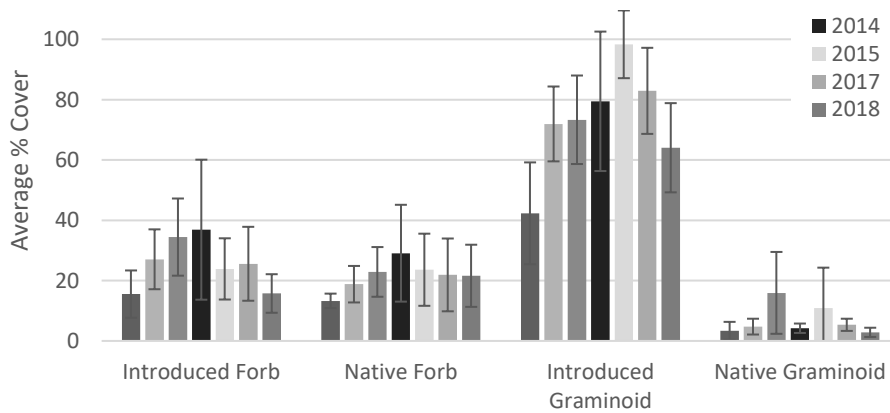
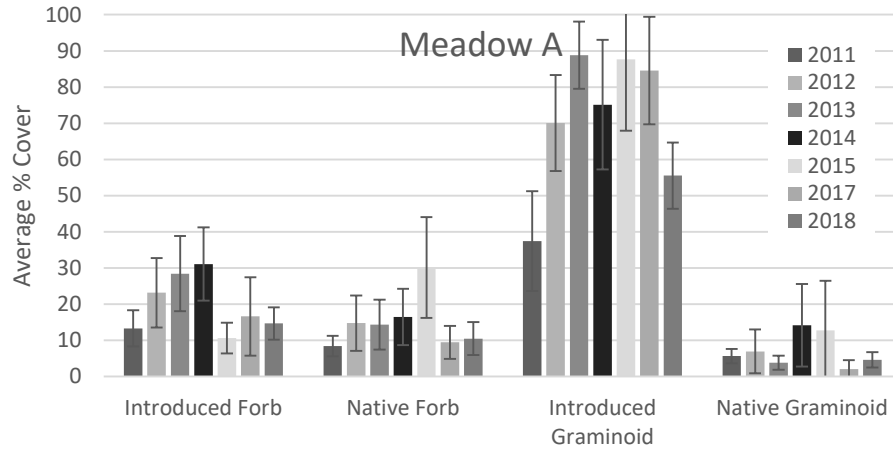
	Meadow A		Meadow B		Meadow C		Grand Total	
	Mature Racemes	Percent Aborted	Mature Racemes	Percent Aborted	Mature Racemes	Percent Aborted	Mature Racemes	Percent Aborted
2006	245	9%	375	13%	145	21%	765	14%
2007	881	9%	1,482	4%	810	5%	3,173	6%
2008	891	9%	1,027	6%	432	9%	2,350	8%
2009	415	18%	1,004	7%	55	42%	1,474	12%
2010	1,860	5%	1,678	4%	108	28%	3,646	5%
2011	1,978	5%	1,845	4%	192	18%	4,015	5%
2012	1,328	7%	969	7%	127	24%	2,424	8%
2013	71	59%	122	39%	44	50%	237	49%
2014	1,108	8%	627	11%	311	12%	2,046	10%
2015	129	47%	120	35%	177	11%	426	32%
2016	209	42%	197	31%	217	20%	623	32%
2017	1,996	8%	736	11%	881	6%	3,613	8%
2018	1,984	8%	587	14%	471	11%	3,042	10%

	Meadow A		Meadow B		Meadow C		All Meadows	
	Cover (m ²)	Mature racemes/m ²	Cover (m ²)	Mature racemes/m ²	Cover (m ²)	Mature racemes/m ²	Cover (m ²)	Mature racemes/m ²
2006	39.3	6	44.9	8	11.5	13	95.7	8
2007	37.3	24	37.7	39	21.1	38	96.1	33
2008	45.3	20	45.9	22	10.6	41	101.8	23
2009	49.5	8	50.1	20	10.7	5	110.3	13
2010	65.3	28	49.6	34	12.0	9	126.9	29
2011	86.8	23	60.3	31	15.2	13	162.3	25
2012	86.5	15	70.0	14	13.6	9	170.1	14
2013	42.9	2	25.5	5	11.2	4	79.6	3
2014	80.4	14	51.6	12	17.8	17	149.8	14
2015	49.2	3	21.4	6	21.7	8	92.3	5
2016	47.3	4	18.9	10	14.0	15	80.2	8
2017	87.5	23	34.7	21	29.5	30	151.7	24
2018	110.3	18	27.9	21	25.2	19	163.4	19

APPENDIX G: COUNT OF NUMBER OF SISYRINCHIUM HITCHCOCKII BY SIZE CLASS IN MEADOW C AT OAK BASIN FROM 2012-2018. R NUMBERS REPRESENT THE NUMBER OF INFLORESCENCES RECORDED PER STEM (R1, R2, R3, ETC.).

Size Class	2012	2013	2014	2015	2016	2017	2018
Vegetative	42	47	26	44	30	15	17
R1	55	40	17	13	8	21	12
R2	14	10	9	5	2	20	10
R3	7	5	5	1	1	8	4
R4	1	1	7	0	1	1	1
R5	1	1	0	1	0	1	1
R6	1	0	12	0	0	0	0
R7	0	0	7	0	0	0	0
R8	0	1	0	0	0	0	0
R9	1	0	0	0	0	0	0
R10	0	0	0	0	0	0	0
R11	0	0	0	0	0	0	0
R12	0	0	1	0	0	0	0
R13	0	0	0	0	0	0	0
R14	0	0	1	0	0	0	0
R19	0	0	0	0	0	0	1
Total Reproductive Individuals	80	58	59	20	12	51	29
Total Reproductive Stems	128	92	225	31	19	89	72
Total number of plants	122	105	85	64	42	66	46

APPENDIX H: AVERAGE PERCENTAGE OF INTRODUCED AND NATIVE FORB AND GRAMINOID SPECIES IN LUPINE HABITAT FROM 2011-2018 IN MEADOWS A, B, AND C. ERROR BARS REPRESENT 95% CI.



APPENDIX I. CONTACTS, DIRECTIONS, AND GEAR LIST FOR OAK BASIN

Private Landowner contact

(access is through his property, but you do not need to contact)

Jim Merzenich
Oak Basin Tree Farm
7410 Oleson Road, PMB #319
Portland, OR 97223
503.246.4202
cell: 503.799.6772
merzenich@comcast.net

Directions:

To Meadows A, B, and C

South on I-5, take exit 216

Head East towards Brownsville. Turn right (at Chevron Station), onto Washburn Road, this will become Gap Road.

Turn left onto Northernwood Rd. (5.8 miles from the freeway.) Reset the mileage as you turn onto Northernwood.

At the end of Northernwood Rd, the road turns to gravel and forks. Take the left gated fork (use key if necessary). (0.7 miles)

At 1.0 miles stay right (don't go to the barn/equipment area).

At 1.2 go right.

At 1.6 go right (road is grassier and rough)

Park at 2.3 miles and walk up the road to the base of Meadow A.

See maps and photos for directions to meadows.

To Doghead Meadow

South on I-5 to Brownsville/Hwy 228 exit 216

Take HWY 228 east, just over 6 miles, to Courtney Creek Road.

(Start mileage once turn onto Courtney Creek Road)

Courtney Creek Road becomes Timber Road at ~2.5 miles

Continue past gravel pile (on left) to total of 7.3 miles

Park at (mostly) blocked road, 14-2.34 (signed). Walk in to end of road (approx. 1.5 - 2 miles).
Old ATV trail to right through trees to meadow (flagged and sign saying no motorized traffic).

Equipment needed:

Eugene BLM Key for Oak Basin Site

Data sheets

Last year's report

Last year's data

Maps and Gazetteer

Rulers – 1 per person

2 tatums and extra pencils

Meter tapes: Minimum 6 tapes, (more is better- at least 3- 100m tapes)

1m² plot frame (for community monitoring)

1m poles – 2 per person (for measuring/sectioning large patches)

Candy canes (at least 2x the number of tapes)

Pin flags – white (marks lupine), pink (marks plot corners), other color (for various other uses)

Compass

Flagging

Rebar, conduit, or fiberglass x3 (for replacement, if necessary)

Plot tags and wires x3 (for replacement, if necessary)

Extra water

Health and Safety Box

Tecnu

First aid kit