

Nestucca Bay National Wildlife Refuge, Cannery Hill Prairie Restoration: 2015 Report and Updated Restoration Plan



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Report to the U.S. Fish & Wildlife Service

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Institute for Applied Ecology



PREFACE

In 2011, the Institute for Applied Ecology (IAE) was contracted by the U.S. Fish and Wildlife Service (USFWS) to conduct and advise on prairie habitat restoration at the Nestucca Bay National Wildlife Refuge Cannery Hill Unit in Tillamook County, Oregon. The primary goal of the project is to convert degraded grasslands of the Cannery Hill Unit from non-native pasture grasses to native coastal grasses and forbs with an emphasis on the species and structure required to support the federally threatened Oregon silverspot butterfly (*Speyeria zerene hippolyta*).



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Several IAE staff have also been involved in this project, and much appreciation is due for their efforts. Ecological Education Coordinator Larkin Guenther spearheaded the propagation program at CCCC. Botany Technician Ashley Ottombrino-Haworth was essential to the success of seed collection efforts, and Restoration Technician Meredith Barrett was a key player in habitat management and seed collection efforts during the summer. Guy Banner regularly helped with seed collection. We also thank Restoration Technician Andy Neill for support with on-the-ground activities and seed collection, and Michelle Allen and Rebecca Currin for their project support behind the scenes. IAE's AmeriCorps NCCC Silver 5 Team was integral in fall planting efforts.

Cover photograph: Nestucca Bay National Wildlife Refuge, Cannery Hill Area 3/5, April 27, 2015. Young establishing *Festuca ammobia*. Photo by Ian Silvernail.

Photographs: Unless otherwise noted, all photographs are by Ian Silvernail.

SUGGESTED CITATION

Silvernail, I.S. 2015. Nestucca Bay National Wildlife Refuge, Cannery Hill Prairie Restoration: 2015 Annual Report and Updated Restoration Plan. Institute for Applied Ecology, Corvallis, OR, 31 pages.

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Nestucca Bay National Wildlife Refuge, Cannery Hill Prairie Restoration: 2015 Report and Updated Restoration Plan

REPORT TO THE U.S. FISH AND WILDLIFE SERVICE

2015 MANAGEMENT ACTIONS

In 2011, the Institute for Applied Ecology (IAE) was contracted by the USFWS to conduct prairie restoration at the Nestucca Bay National Wildlife Refuge, Cannery Hill Unit in Tillamook County, Oregon. The project goal is to convert degraded grasslands of Cannery Hill (Figure 1), dominated by non-native pasture grasses, to native coastal graminoids and forbs, with an emphasis on the species and structure required to support the Oregon silverspot butterfly (*Speyeria zerene hippolyta*, Federally listed as threatened). Site activities in 2015 focused on exotic species control in several restoration units, early blue violet (*Viola adunca*) plug planting, and forb seeding and planting. A complete list of actions implemented on site in 2015 can be found in Table 1. A site map indicating the restoration areas can be found in Figure 2.



Figure 1. March 10, 2011. Area 3/5, looking north prior to any restoration activities. Area 2 is in the distance, framed by the tree line. Area 1 is the most distant open area just left of the top-center of Area 2.

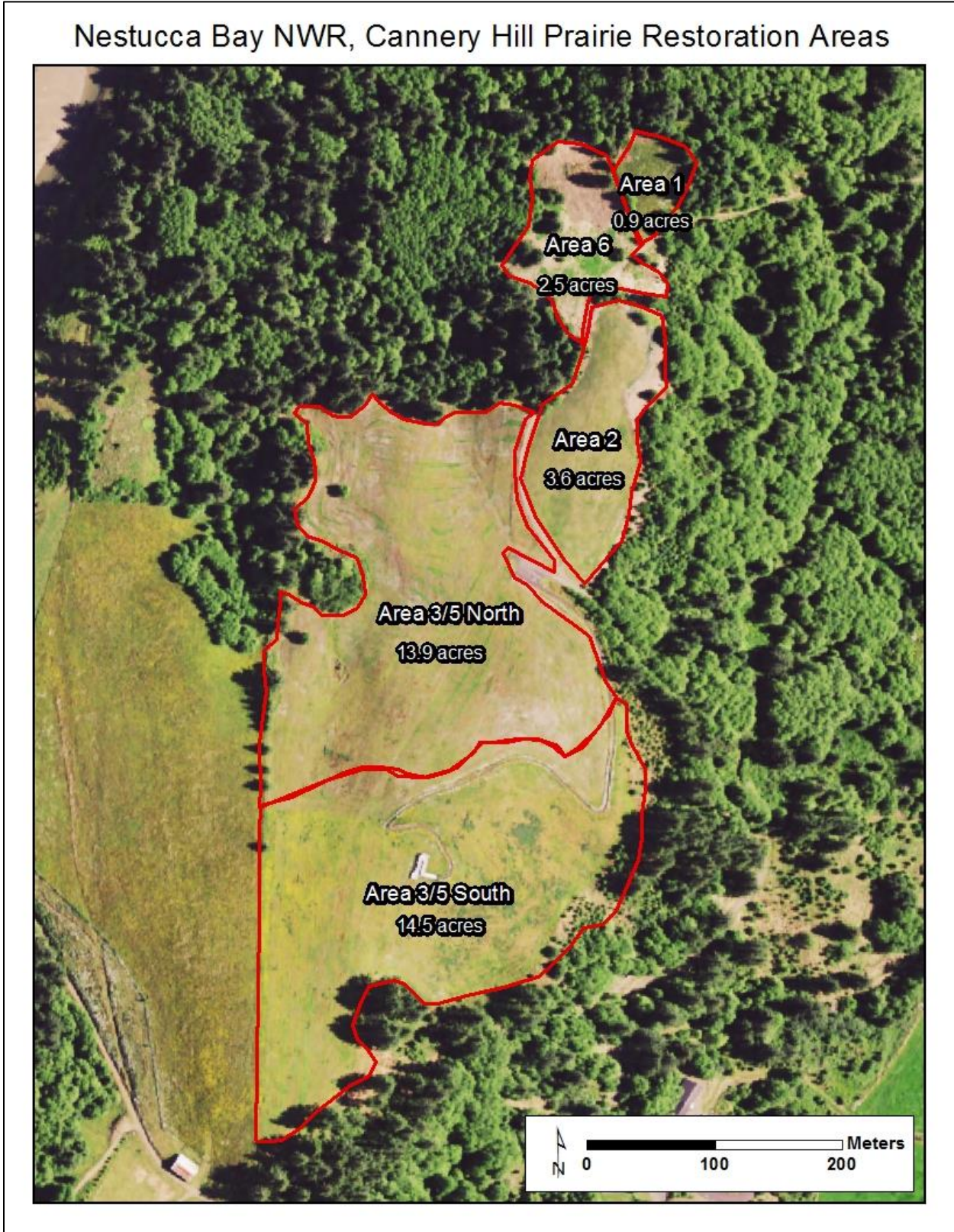


Figure 2. Restoration areas at Cannery Hill, Nestucca Bay NWR.

Table 1: Summary of Cannery Hill restoration actions performed in 2015. Photos of select management actions are referenced in the “Task” column and can be found after the table.

Date	Staff	Area	Task
Mar-Oct	USFWS	2	Spot foam broadleaf weeds with 10% Element 4 on multiple dates (3/8, 5/24, 6/7, 6/15, 6/22, 8/23, 10/21).
3.9, 3.16	USFWS	2	Spot spray broadleaf weeds with 3% GlyStar Original + 1% R-11.
3.13, 3.26	USFWS	2	Spot foam all weeds in violet patches with 35% GlyStar Original.
3.18, 3.19, 4.2	Integrated Resource Management	3/5 South	Spot spray with 3% Rodeo + 1% Agridex. Target weeds include <i>Hypochaeris radicata</i> , <i>Ranunculus repens</i> , <i>Crepis capillaris</i> , and <i>Holcus lanatus</i> (Figure 3).
3.19	USFWS	2	Spot foam test on grasses in violet patches. Used Poast at 1.5%, 5%, 10%, and 20%.
3.19, 5.25	USFWS	2	Spot spray broadleaf weeds with 2% Element 4 + 0.25% R-11.
3.29	USFWS	1, 2 perim.	Broadcast spray grasses with 1% Fusilade + 1% MSO + 0.25% R-11.
3.30	USFWS, IAE	3/5 South	Attempt to drill forb seed with Truax 5-foot no-till drill.
3.31-4.2	USFWS, IAE, North Face volunteers, CCCF inmates	2	Plant 5,000 plugs each of <i>Anaphalis margaritacea</i> , <i>Solidago elongata</i> , and <i>Symphyotrichum chilense</i> (Figure 4).
4.9	USFWS	3/5 South	Chain drag harrow area west of viewing deck to remove thatch prior to seeding.
4.9	USFWS, IAE	3/5 South, 2 perim.	Sow forb seed with Dew Drop Drill (3/5) and Earthway hand broadcast seeder (2).
5.9-5.11	USFWS	6	Broadcast spray all vegetation with 3% GlyStar Original + 1% R-11.
5.24	USFWS	2	Spot foam test on grasses in violet patches. Fusilade at 10% and 20%.
5.26	USFWS	2	Broadcast spray all vegetation in sprayed out patches with 5% GlyStar Original + 1% R-11.
5.26	USFWS	2	Spot foam rattail fescue with 20% Poast.
May-June	USFWS	2	Spot foam velvet grass with 20% Fusilade on multiple dates (5/26, 6/5, 6/8).
5.28	Habitat Restoration, LLC	3/5 North	Spray with MCPA (1 quart/acre) + Detonate (8 oz/acre) + R-11 (1 quart/100 gallons).
6.4	USFWS	1	Test wiping of broadleaf weeds with 100% GlyStar Original.
6.8	USFWS	2	Spot foam broadleaf weeds with 20% Element 4.
6.12, 6.17	USFWS	1	Spot foam broadleaf weeds with 10% Element 4.
6.15	USFWS	1	Test wiping of broadleaf weeds with 50% GlyStar Original.
6.22	USFWS	2	Spot foam broadleaf weeds with 50% GlyStar Original.

Date	Staff	Area	Task
June-July	IAE, USFWS	3/5	Cut perimeter vegetation and <i>Phalaris arundinacea</i> in drainages with string trimmers (6/22, 6/23, 7/6, 7/15, 7/17, 7/20, 7/23).
June-Sept	IAE, USFWS	2, 3/5	Hand weeding <i>Vulpia myuros</i> , <i>Senecio sylvaticus</i> , and violet patches in perimeter of Area 2 (6/22, 6/23, 6/25, 6/26, 6/29, 6/30, 8/5, 8/21, 8/24, 8/27, 8/28, 9/3, 9/10, 9/11, 9/15, 9/16, 9/17).
7.2	USFWS	6	Spot spray <i>Senecio sylvaticus</i> with 3% GlyStar Original + 1% R-11.
7.2	USFWS	3/5	Spot spray broadleaf weeds with 3% GlyStar Original + 1% R-11.
7.1, 7.9, 7.13	USFWS, IAE	2	Monitoring of mow/burn/control plots.
7.24	USFWS	1	Test wiping of broadleaf weeds with 33% GlyStar Original.
7.24	USFWS	1	Test wiping of broadleaf weeds with 10% Element 4.
7.27	USFWS	2	Spot foam broadleaf weeds with 35% GlyStar Original.
July-Sept	IAE	3/5	Spot spray all weeds with 2% Rodeo + 1% Agridex on multiple dates (7/27, 7/28, 7/30, 8/3, 8/4, 8/10, 8/17, 8/24, 8/27, 9/3, 9/11, 9/15, 9/17, 9/22).
July-Sept	USFWS	3/5	Spot spray all weeds with 2% GlyStar Original + 1% R-11 on multiple dates (7/28, 8/3, 8/6, 8/9, 8/12, 8/23, 8/24, 8/27, 9/4, 9/11, 9/15).
8.9	USFWS	3/5	Test spot spray broadleaf weeds with 4% Element 4 + 0.25% R-11.
8.21	USFWS, IAE	3/5	Trial use of 4' hand-held weed wiper with 33% Rodeo. Target weeds include <i>Hypochaeris radicata</i> and <i>Rumex acetosella</i> .
9.3	USFWS	2	Spot foam all weeds with 25% GlyStar Original.
9.9	USFWS, IAE	3/5	Spot spray with 8 oz/acre Milestone in large weedy patch west of viewing deck (Figure 5).
9.18	USFWS	2	Broadcast spray all vegetation in proposed burn area with 20% Avenger.
9.21	USFWS	2	Attempted broadcast burn in south end of unit. (Figure 6-8).
9.28	USFWS	6	Spot spray all vegetation with 2% GlyStar Original + 1% R-11.
9.30, 10.1	USFWS	3/5, 2	Mow all vegetation at 4". (Area 2 mowing excluded nectar plantings)
10.5	USFWS	2	Spot foam broadleaf weeds with 20% GlyStar Original.
10.5, 10.14	USFWS	2 perim.	Spot spray all weeds with 2% Rodeo + 1% Agri-dex.
Oct	USFWS	6	Spot spray all vegetation with 2% Rodeo + 1% Agridex (10/11, 10/12, 10/21, 10/22).
10.16	USFWS	2 perim.	Spot spray young rattail fescue with 0.4% Fusilade + 0.8%MSO.
10.26, 10.27	USFWS	3/5	Spot spray all weeds in patches where violets are scheduled to be planted in November with 2% Rodeo + 1% Agridex.
10.27	USFWS, The North Face volunteers	3/5	Raked thatch to prepare for violet and oatgrass seeding (west of viewing deck only).

Date	Staff	Area	Task
Nov	USFWS	3/5	Spot spray weeds in south and east portions of unit with 2% GlyStar Original + 1% Agridex on multiple dates (11/3, 11/5, 11/6, 11/9, 11/10, 11/11, 11/12, 11/29).
11.7	USFWS, IAE, Oregon Zoo volunteers	3/5	Plant 4000 violet plugs in patches.
11.20-21	USFWS	1, 2, 6	Attempted Blackliner propane burn.
11.23	IAE, AmeriCorps	3/5 South	Plant 3208 violet plugs in patches.
11.23-24	IAE, AmeriCorps	3/5 South	Salvage ~4000 <i>Fragaria chiloensis</i> runners from lower parking lot. Plant into new violet patches.
11.24	IAE, AmeriCorps	2 perim.	Hand weed violet patches.
11.25	IAE, AmeriCorps	3/5 South	Plant 350 1 and 2 gallon pots of <i>Sidalcea hirtipes</i> (Figure 9).

Figure 3. March 18. IRM spot spraying in Area 3/5.



Figure 4. April 1. Women from CCCF planting nectar plugs in Area 2.



Figure 5. August 31. Large *Hypochaeris radicata*-dominated patch. This patch was sprayed with Milestone on September 9.



Figure 6.
September 21.
Attempted
broadcast burn
in Area 2.
Areas 1 and 6,
also planned
for burning,
were not
attempted.



Figure 7.
September 21.
Post-burn.



Figure 8.
September 24.
Area 2 from
above in Area
3/5. Boundaries
of the attempted
burn area can
be seen.



Figure 9.
November 25.
AmeriCorps
NCCC planting
Sidalcea
hirtipes.



MONITORING

Annual photopoint monitoring

On June 4, monitoring photos were taken in all four units. One point was chosen in each of the four restoration areas, except Area 3/5, which has two photopoints (Figure 10). Latitude and longitude of each photopoint is listed in Table 2. At each point, four photos were taken, one in each of the cardinal directions. Photos are included in Figures 11-15.

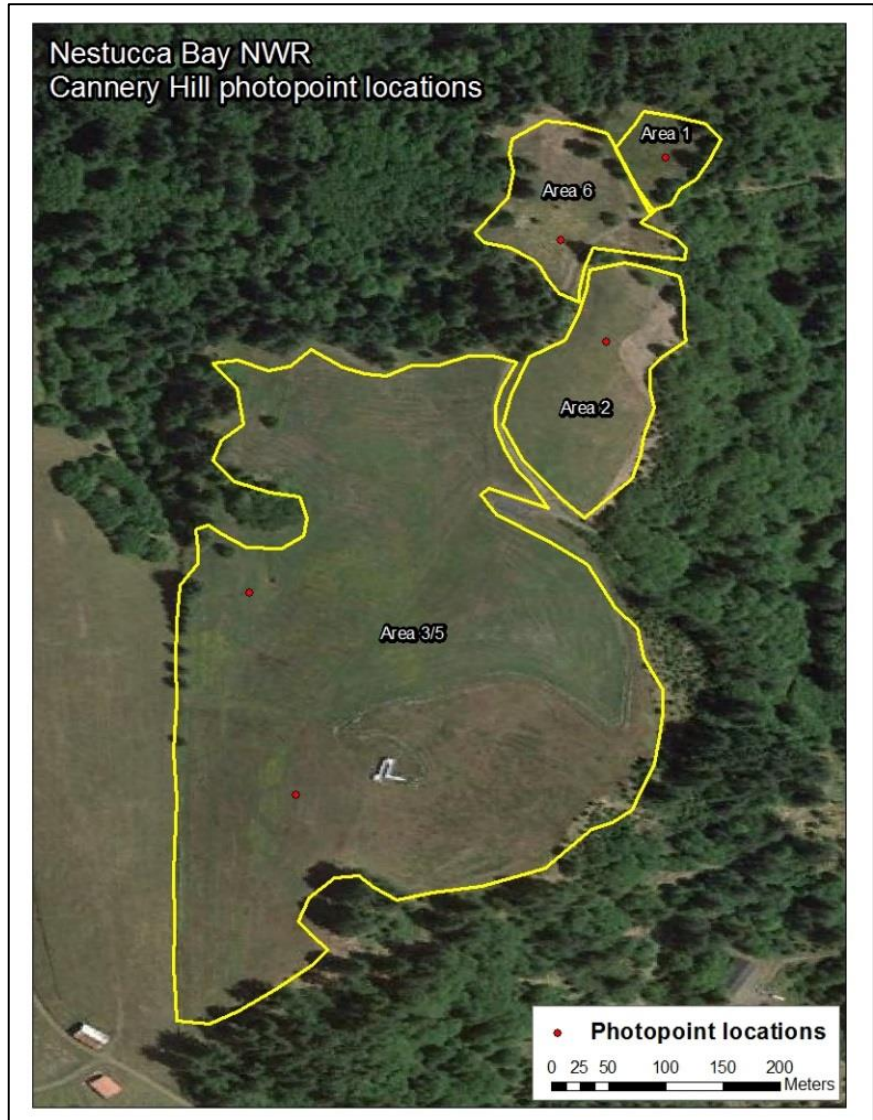


Figure 10: Locations of photopoints at Cannery Hill.

Table 2: Monitoring photopoint locations.

Restoration Area	Latitude	Longitude
Area 1	45.169262	-123.951846
Area 2	45.167811	-123.952311
Area 3/5	45.16425	-123.954754
Area 3/5	45.165837	-123.955119
Area 6	45.168613	-123.952676

Figure 11: Area 1 photopoint monitoring (clockwise from upper left: facing north, east, south, west)



Figure 12: Area 2 photopoint monitoring (clockwise from upper left: facing north, east, south, west)



Figure 13: Area 3/5 photopoint monitoring (clockwise from upper left: facing north, east, south, west)



Figure 14: Area 3/5 photopoint monitoring (clockwise from upper left: facing north, east, south, west)



Figure 15: Area 6 photopoint monitoring (clockwise from upper left: facing north, east, south, west)



Experimental management plots in Area 2

In the fall of 2014, in response to low native forb seed establishment rates, likely due to the high cover of *Festuca ammobia*, three sets of plots were established in Area 2 to assess the impact of site preparation on seedling establishment and weed colonization (Figure 16). The goal of this assessment was to inform appropriate *Festuca ammobia* management in 2015. Each plot contained 3 separate 5m x 5m treatment plots. Site preparation treatments were the following: 1) propane torch burning to remove all thatch and living vegetation, 2) mowing at 4", 3) control (no treatment). Sites were seeded on December 23, 2014 with *Achillea millefolium*, *Artemisia suksdorfii*, *Solidago elongata*, *Symphytotrichum chilense*, and *Trifolium wormskioldii*. Information on seeding rates can be found in the report titled "Nestucca Bay National Wildlife Refuge, Cannery Hill Prairie Restoration: 2014 Annual Report and Updated Restoration Plan" (Silvernail, 2015).



Between July 1 and 13, 2015, five 1m x 1m plots were randomly placed within each 5m x 5m treatment plot. In each 1m² plot, percent cover and the number of individuals of all species present were recorded. For *Festuca ammobia*, only the percent cover was calculated, as it is not possible to count the number of individuals when mature. Percent relative cover and number of individuals for each species and group of species were analyzed using one-way ANOVA. Where significant differences were detected across treatment groups, a Fisher's LSD Multiple Comparisons Test was used to determine differences between individual treatment groups. Results are presented in Table 3 below.

Figure 16: Location of experimental management plots in Area

Table 3: Mean number of individuals and mean percent relative cover by species or group of species across three site preparation treatment types. Superscript letters associated with the means indicate significant differences between treatment groups as indicated by a Fisher’s LSD Test; these letters are omitted if no significant difference across treatment groups was detected by a one-way ANOVA ($p > 0.05$). Identical letters for a species or group of species indicate no significant difference between treatment groups; different letters indicate a difference between treatment groups. Species and groups of species with significant differences across treatment types ($p \leq 0.05$) are underlined.

Species/Group of species	# of individuals				percent relative cover			
	p-value	Mean			p-value	Mean		
		control	mow	burn		control	mow	burn
All introduced species	<u>0.001</u>	<u>15.6^A</u>	<u>16.4^A</u>	<u>253.3^B</u>	<u>0.001</u>	<u>1.7^A</u>	<u>1.8^A</u>	<u>12.2^B</u>
All introduced species except <i>Vulpia myuros</i>	<u>0.02</u>	<u>7.6^{AB}</u>	<u>5.3^A</u>	<u>12.6^B</u>	<u>0.02</u>	<u>1.6^{AB}</u>	<u>1.2^A</u>	<u>2.4^B</u>
All native species	<u>0.0001</u>	<u>7.2^A</u>	<u>29.3^A</u>	<u>84.1^B</u>	<u>0.001</u>	<u>96.7^A</u>	<u>94.9^A</u>	<u>88.3^B</u>
All seeded native species	<u>0.0003</u>	<u>7.0^A</u>	<u>29.2^A</u>	<u>79.4^B</u>	0.07	0.9	1.5	2.2
All non-seeded native species	0.08	0.2	0.1	4.7	<u>0.0002</u>	<u>95.8^A</u>	<u>93.4^A</u>	<u>86.2^B</u>
All native species except <i>Festuca ammobia</i>	N/A				<u>0.02</u>	<u>1.1^A</u>	<u>1.6^A</u>	<u>2.7^B</u>
All non-seeded native species except <i>Festuca ammobia</i>	N/A				<u>0.02</u>	<u>0.1^A</u>	<u>0.1^A</u>	<u>0.6^B</u>
<i>Achillea millefolium</i>	<u>0.0007</u>	<u>4.1^A</u>	<u>18.9^A</u>	<u>44.3^B</u>	0.23	0.5	0.6	0.9
<i>Acmispon parviflorus</i>	0.38	0	0.1	0	0.38	0	0.03	0
<i>Anaphalis margaritacea</i>	0.30	0.1	0	0.2	0.39	0.1	0	0.2
<i>Artemisia suksdorfii</i>	0.16	0	0	0.2	0.13	0	0	0.1
<i>Carex</i> sp. (likely <i>rossii</i>)	<u>0.04</u>	<u>0^A</u>	<u>0^A</u>	<u>0.2^B</u>	<u>0.04</u>	<u>0^A</u>	<u>0^A</u>	<u>0.1^B</u>
<i>Cirsium vulgare</i>	0.15	0.8	0.1	0.2	0.39	0.1	0.03	0.1
<i>Crepis capillaris</i>	0.61	0	0.1	0.1	0.61	0	0.03	0.03

Species/Group of species	# of individuals				percent relative cover			
	p-value	Mean			p-value	Mean		
		control	mow	burn		control	mow	burn
<i>Digitalis purpurea</i>	0.61	0.1	0.1	0	0.61	0.03	0.03	0
<i>Festuca ammobia</i>	N/A				<u>0.0001</u>	<u>95.7^A</u>	<u>93.3^A</u>	<u>85.6^B</u>
<i>Fragaria chiloensis</i>	0.38	0.1	0	0	0.38	0.03	0	0
<i>Geranium dissectum</i>	0.38	0	0.1	0	0.38	0	0.03	0
<i>Geranium molle</i>	0.38	0	0	0.2	0.38	0	0	0.03
<i>Holcus lanatus</i>	0.23	2.1	0.2	1.9	<u>0.04</u>	<u>0.2^{AB}</u>	<u>0.03^A</u>	<u>0.3^B</u>
<i>Hypochaeris radicata</i>	0.31	0.9	0.9	1.8	0.36	0.2	0.3	0.4
<i>Juncus bufonius</i>	0.12	0	0	4.2	<u>0.04</u>	<u>0^A</u>	<u>0^A</u>	<u>0.2^B</u>
<i>Phalaris arundinacea</i>	0.39	1.2	0.6	1.6	0.13	0.3	0.1	0.3
<i>Picea sitchensis</i>	0.61	0	0.1	0.1	0.61	0	0.03	0.03
<i>Poa annua</i>	0.27	0	0	0.5	0.13	0	0	0.1
<i>Ranunculus repens</i>	0.93	0.3	0.2	0.2	0.87	0.1	0.1	0.1
<i>Rumex acetosella</i>	0.46	0.5	1.3	2.5	0.16	0.1	0.1	0.4
<i>Rumex crispus</i>	0.10	1.2	1.7	3.6	0.45	0.4	0.4	0.7
<i>Solidago elongata</i>	<u>0.0006</u>	<u>0.6^A</u>	<u>4.5^A</u>	<u>15.4^B</u>	<u>0.01</u>	<u>0.1^A</u>	<u>0.4^{AB}</u>	<u>0.5^B</u>
<i>Stachys mexicana</i>	0.38	0.1	0	0	0.38	0.03	0	0
<i>Symphotrichum chilense</i>	<u>0.007</u>	<u>1.8^A</u>	<u>5.7^A</u>	<u>19.4^B</u>	0.13	0.3	0.6	0.7
<i>Taraxacum officinale</i>	0.38	0.1	0	0	0.38	0.03	0	0
<i>Trifolium repens</i>	0.25	0.5	0.1	0.1	0.19	0.1	0.03	0.03
<i>Vulpia myuros</i>	<u>0.001</u>	<u>8.0^A</u>	<u>11.1^A</u>	<u>240.7^B</u>	<u>0.002</u>	<u>0.2^A</u>	<u>0.6^A</u>	<u>9.8^B</u>

Of the five native species that were seeded in the treatment plots, three species, *A. millefolium*, *S. elongata*, and *S. chilense*, showed a significantly higher number of individuals in the burn plots versus the mow or control. However, only *S. elongata* showed any differences in percent relative cover across treatments, where burned plots showed significantly higher relative cover of the species than control plots.

Mowed plots did not differ from either the burn or control. There were no significant differences across treatment plots for another seeded species, *A. suksdorfii*. No germinants were detected for the fifth seeded species, *T. wormskioldii*.

These results suggest that burning prior to seeding will achieve a higher number of germinants of three of the five seeded species compared to mowing or doing nothing prior to seeding. The lack of significant difference in percent relative cover between treatments (other than in *S. elongata*) may be due to the short period of time that seed of these species had to establish prior to monitoring. Monitoring in the second year may be more likely to reveal differences.

In general, the burning treatment had the most significant impact on the response variables. While achieving a greater number of germinants for three of five seeded species and significantly reducing the relative cover of *F. ammobia*, burning also significantly increased the cover of all non-seeded native species when *F. ammobia* was excluded from the analysis. However, burning is known to increase the opportunity for colonization by introduced species, and this case was no exception. Burning increased the relative cover of all introduced species. Burning significantly increased the number of individuals and percent relative cover of *V. myuros*. *V. myuros* had the highest relative cover and highest number of individuals of all introduced species. Burning also significantly increased the relative cover all of introduced species combined when *V. myuros* is excluded from the analysis.

In light of these results, it was determined that burning, compared to other site preparation treatments tested, provided the best opportunity for improving the native diversity in areas dominated by high cover of *F. ammobia*. While burning did increase introduced species cover significantly, it was determined that without it, successful establishment of native seeded species would be very challenging. However, it is important to remember that is possible that broadcast burning may illicit a different response than the propane torch burning executed in this experiment.

PLANTINGS AND SEEDINGS

Areas 2 and 3/5 Spring Forb Seeding

On March 30, an attempt was made to use a Truax 5 foot no-till drill to seed forbs in Area 3/5 South. After a few short passes, it was determined that the tractor and drill combination was excessively heavy for the soils in their current saturation state and that too much damage would be caused by seeding. Activities with the Truax drill were suspended and the seeding was completed with a Dew Drop Dill.

On April 9 and 10, a mixture of forb seeds were sown in Area 3/5 South (Table 4) and around the perimeter of Area 2 (Table 5). See Figure 17 for seeding locations. Due to thick *Festuca ammobia* and its thatch, the portion of Area 3/5 that lies west of the viewing deck was prepared for seeding with a chain drag harrow pulled by a Gator. The rest of the unit contained fescue at a lower density and was not harrowed. Seeding in Area 3/5 was done with 2 Dew Drop Drills, one pulled by a Gator and the other by an ATV. The Dew Drop Drill used to sow the portion of Area 3/5 South that lies east of the

viewing deck was missing the harrow tines designed to scratch the seed into the soil surface. Seed in Area 2 was sown with an Earthway handheld broadcast seeder.

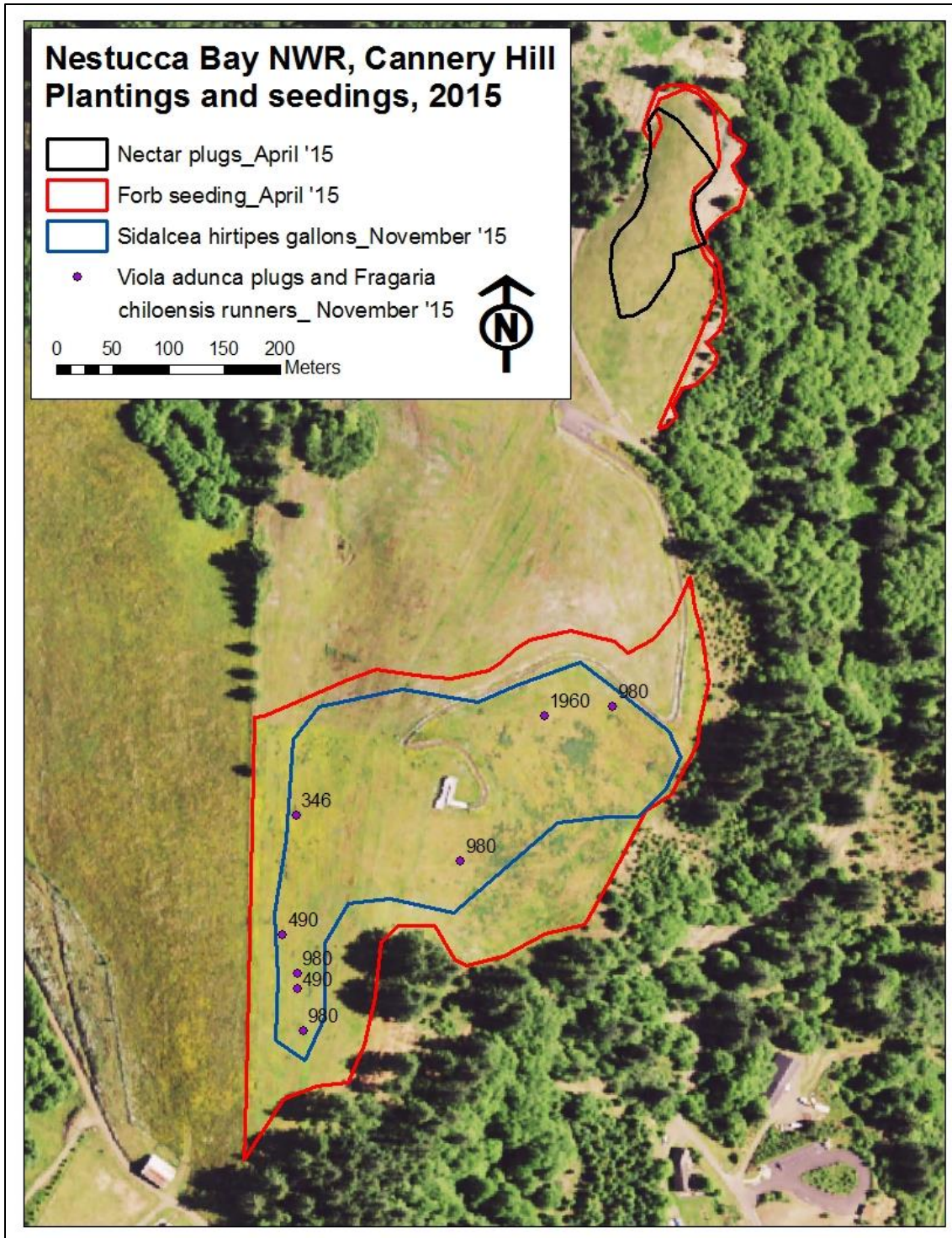


Figure 17: Locations of all 2015 seedings and plantings on Cannery Hill. Numbers indicate the number of violet plugs planted at each waypoint.

Table 4: Contents of mix used to seed the 14.5 acres in Area 3/5 South. PLS = Pure live seed. The number between the two dashes in the lot number indicates the year in which the seed was harvested. Estimates are starred (*). TZ indicates a tetrazolium chloride test was used.

Species	Lot number	Purity	Germination	Bulk lbs seeded	PLS lb	lb/acre PLS
<i>Achillea millefolium</i>	SG1-08-CC448	87.72%	70%*	4.0	2.5	0.17
<i>Achillea millefolium</i>	SG1-09-CC448	76.12%	93%	10.0	7.1	0.49
<i>Artemisia suksdorfii</i>	SG1-11-CC560	89.79%	69%	11.8	7.3	0.50
<i>Solidago elongata</i>	SG1-13-CC497	85%*	60%*	44.3	22.6	1.56
<i>Symphotrichum chilense</i>	SG1-11-CC449	62.87%	65%	22.7	9.3	0.64
<i>Trifolium wormskioldii</i>	SG1-11-CC619	95.26%	63% (TZ)	17	10.2	0.70

Table 5: Contents of mix used to seed the 0.75 acres in the perimeter of Area 2. PLS = Pure live seed. The number between the two dashes in the lot number indicates the year in which the seed was harvested. For purity and germination information for each seed lot, see Table 4 and cross reference with the lot number.

Species	Lot number	Bulk lbs seeded	PLS (lb)	lb/acre PLS
<i>Achillea millefolium</i>	SG1-09-CC448	1.0	0.71	0.94
<i>Artemisia suksdorfii</i>	SG1-11-CC560	1.0	0.62	0.83
<i>Solidago elongata</i>	SG1-13-CC497	2.3	1.17	1.56
<i>Symphotrichum chilense</i>	SG1-11-CC449	1.5	0.61	0.82
<i>Trifolium wormskioldii</i>	SG1-11-OS619	1.65	0.99	1.32

Spring nectar plug planting

Between March 31 and April 2, 15,000 plugs of three nectar species were planted in Area 2 (Figure 17). This included 5,000 plugs each of *Anaphalis margaritacea*, *Solidago elongata*, and *Symphotrichum chilense*. Plugs were planted only in the middle of the restoration unit in order to preserve the ability to do aggressive restoration in the rest of the unit. The rest of the unit is heavily dominated by *Festuca ammobia* and will likely require restoration actions to manage the fescue that are inconsistent with the presence of forbs.

Fall plantings

On November 7 and 23, a total of 7,208 *Viola adunca* plugs were planted in Area 3/5 South (Figure 17). On November 24, approximately 4,000 *Fragaria chiloensis* plugs were planted in Area 3/5 South inside recently planted violet patches. On November 25, approximately 350 1 and 2-gallon pots of *Sidalcea hirtipes* were planted throughout Area 3/5 South.

RESTORATION PLANT MATERIALS

Seed collection

In 2015, an effort to increase the diversity of species available for prairie restoration was expanded. A total of 34 collection sites were identified. Sites were scouted in the spring and summer and locations of target species were mapped. Seed collection began on May 11 and ended on September 29. Table 6 below shows the results of these efforts. Figures 18 and 19 contain photographs of seed collection efforts.

Table 6: Species, number of collection sites, and total quantity of seed collected to date. The majority of the collections below are from 2015. A small number were collected in 2013 and 2014.

Species	Common Name	# collection sites	Total quantity collected (g)
<i>Acmispon americanus</i>	American bird's-foot trefoil	4	18.0
<i>Acmispon parviflorus</i>	small flowered lotus	4	72.8
<i>Allium cernuum</i>	nodding onion	2	6.0
<i>Angelica hendersonii</i>	sea coast angelica	7	743.2
<i>Angelica lucida</i>	sea watch	8	1,118.0
<i>Bromus carinatus</i>	California brome	7	457.4
<i>Brodiaea coronaria</i>	crown brodiaea	2	<0.01
<i>Bromus sitchensis</i>	Sitka brome	6	455.5
<i>Calamagrostis nutkaensis</i>	Pacific reedgrass	10	1,245.2
<i>Camassia quamash</i> spp. <i>maxima</i>	common camas	3	16.6
<i>Carex obnupta</i>	slough sedge	7	324.4
<i>Carex rossii</i>	Ross's sedge	2	<0.01
<i>Carex tumulicola</i>	foothill sedge	3	43.5
<i>Castilleja affinis</i> ssp. <i>littoralis</i>	Pacific paintbrush	6	7.0
<i>Cerastium arvense</i>	field chickweed	1	0.4
<i>Chamerion angustifolium</i>	fireweed	19	583.8
<i>Clarkia amoena</i> spp. <i>caurina</i>	northwestern farewell to spring	2	4.2
<i>Conioselinum pacificum</i>	Pacific hemlockparsley	4	237.4

Species	Common Name	# collection sites	Total quantity collected (g)
<i>Daucus pusillus</i>	American carrot	2	75.5
<i>Elymus glaucus</i>	blue wildrye	3	70.2
<i>Eriophyllum lanatum</i>	Oregon sunshine	3	4.4
<i>Fritillaria affinis</i>	checker-lily	1	0.4
<i>Gamochaeta ustulata</i>	featherweed	1	8.9
<i>Heracleum lanatum</i>	cow parsnip	11	3,312
<i>Hosackia gracilis</i>	seaside lotus	1	<0.01
<i>Iris tenax</i>	Oregon iris	4	14.2
<i>Koeleria macrantha</i>	junegrass	1	37.3
<i>Lilium columbianum</i>	Columbia lily	2	0.4
<i>Lomatium martindalei</i>	Cascade desert parsley	3	39.4
<i>Lupinus rivularis</i>	stream lupine	7	553.4
<i>Plectritis brachystemon</i>	shortspur white plectritis	1	9.6
<i>Prunella vulgaris</i> var. <i>lanceolata</i>	heal all	11	115.8
<i>Scrophularia californica</i>	California bee plant	7	46.3
<i>Sidalcea hirtipes</i>	bristlystem checkermallow	5	112.2
<i>Sisyrinchium bellum</i>	western blue-eyed grass	3	3.8
<i>Sisyrinchium californicum</i>	golden-eyed grass	7	178.9
<i>Stachys mexicana</i>	Mexican betony	2	7.1
<i>Vicia nigricans</i> var. <i>gigantea</i>	giant vetch	1	39.8

Figure 18: Some seed collection sites. Clockwise from upper left 1) Cape Perpetua, 2) Cascade Head, 3) North of Otter Crest, 4) Rock Creek



Figure 19: Some species collected in 2015. Clockwise from upper left 1) *Plectritis brachystemon*, 2) *Sidalcea hirtipes*, 3) *Clarkia amoena* ssp. *caurina*, 4) *Daucus pusillus* 5) *Acmispon parviflorus*, and 6) *Iris tenax* and *Castilleja affinis* ssp. *littoralis*.



Grow-out

Based on the results of seed collection efforts, several new species were identified for seed increase. These are listed in Table 7 below. These species were chosen primarily for their reliability (known or expected) in establishment on restoration sites.

Table 7: New seed increase fields started from 2015 seed collections.

Species	Area in growout	Location
<i>Acmispon americanus</i>	205 ft ²	OSU Forest Sciences Lab
<i>Acmispon parviflorus</i>	0.1 acres	NRCS Plant Materials Center
<i>Bromus carinatus</i>	0.1 acres	NRCS Plant Materials Center
<i>Clarkia amoena</i> ssp. <i>caurina</i>	0.1 acres	NRCS Plant Materials Center
<i>Daucus pusillus</i>	205 ft ²	OSU Forest Sciences Lab
<i>Plectritis brachystemon</i>	240 ft ²	OSU Forest Sciences Lab
<i>Prunella vulgaris</i> ssp. <i>lanceolata</i>	0.1 acres	NRCS Plant Materials Center
<i>Sidalcea hirtipes</i>	0.1 acres	NRCS Plant Materials Center

Seed of four bulb-producing species were seeded in trays in December 2015 (Table 8). Trays are kept at the Institute for Applied Ecology. Bulbs will be planted on the restoration site when they have grown to adequate size.

Table 8: Bulbs in production at IAE from 2015 seed collections.

Species	Number of trays (15" x 15" x 5")
<i>Allium cernuum</i>	3
<i>Camassia quamash</i> ssp. <i>maxima</i>	6
<i>Fritillaria affinis</i>	1
<i>Lilium columbianum</i>	1

Plug production

Plug production at the Coffee Creek Correctional Facility (CCCF) in Wilsonville continued through 2015. All plugs are 5.5" Ray Leach containers. In December 2014, 25,000 *V. adunca* were sown. 7,208 of these were planted on the restoration site in November 2015. The remaining 17,000+ will be

planted when they achieve adequate size, likely in fall 2016. In December 2015, an additional 30,000 *V. adunca* were sown. These are scheduled for planting on the restoration site in fall 2016.

15,000 plugs of nectar species (*A. margaritacea*, *S. elongata*, *S. chilense*) were cultivated at CCCF in 2014 and early 2015. These were planted on the restoration site in April 2015.

FUTURE RESTORATION ACTIVITIES

Table 9 lists future restoration activities to occur at Cannery Hill. It is important to note that all restoration requires adaptive management. The Cannery Hill site is especially challenging from a restoration perspective due to weather, previous abundance of aggressive introduced pasture grasses, and the uniqueness of native coastal grassland ecosystems in Oregon. Since restoration efforts began, some units have grown excessive cover of the native *F. ammobia*; future management options for this species are a topic of current conversation, and effective management tools are unclear. For these reasons, some restoration activities listed below have been left intentionally vague as the details will become more evident as restoration of the site progresses. In addition to actions listed here, all areas will receive annual monitoring of restoration progress.

Table 9: Restoration actions at Cannery Hill for the years 2016-2018. X = action should be performed. O = consider performing action if conditions merit.

Management Actions		2016	2017	2018
Area 1, "remnant prairie" (0.9 acres)	Spring broadcast spray (grass specific)	O		
	Fall broadcast spray (grass specific)	O		
	Targeted weed treatments	X	X	X
	Mowing	O	O	O
	Seeding (forbs)	O	O	O
	Fall seeding (other graminoids)	O	O	O
	Supplemental seeding		O	O
	Plug planting	O	O	O
Area 2 (3.6 acres)	Spring broadcast spray (grass specific)	O		
	Fall broadcast spray (grass specific)	O		
	Targeted weed treatments	X	X	X
	Mowing	O	O	O
	Seeding (forbs)	O	O	O
	Fall seeding (other graminoids)	O	O	O
	Supplemental seeding		O	O
	Plug planting	O	O	O
	Fescue and thatch management	X	O	O

	spraying
	mowing
	seeding
	planting
	other

Management Actions		2016	2017	2018
Area 3/5 South (14.5 acres)	Spring broadcast spray (grass specific)	O	O	
	Fall broadcast spray (grass specific)	O		
	Targeted weed treatments	X	X	X
	Mowing	O	O	O
	Seeding (forbs)	O	O	
	Fall seeding (other graminoids)	O	O	
	Supplemental seeding		O	O
	Plug planting	X	O	O
	Fescue and thatch management	X	O	O
Area 3/5 North (13.9 acres)	Spring broadcast spray (grass specific)	X	O	
	Late winter broadcast spray (broadleaf specific)	X		
	Fall broadcast spray (grass specific)	O		
	Summer/fall broadcast spray (broadleaf specific)	O		
	Targeted weed treatments	X	X	X
	Mowing	O	O	O
	Seeding (forbs)	X	O	
	Fall seeding (other graminoids)		O	
	Supplemental seeding		O	O
	Plug planting	X	O	O
Fescue and thatch management	X	O	O	
Area 6 (2.5 acres)	Late winter broadcast spray (non-selective)	X		
	Spring broadcast spray (grass specific)	O	X	O
	Fall broadcast spray (grass specific)	O	X	O
	Targeted weed treatments	X	X	X
	Mowing		O	O
	Late winter seeding (fescue and forbs)	X		
	Fall seeding (other graminoids)		O	O
	Supplemental seeding		O	O
	Plug planting	X	X	O
	Harrowing	X		

Each of these restoration areas contain special treatment zones that will be managed differently than the rest of the area. These are largely related to the presence of native plant species and may change from year to year. No broadcast herbicide applications that are harmful to the species in question should be used in these areas. Each area should be assessed individually prior to management actions.

Additionally, the perimeters of Areas 2, and 3/5 have not been treated in the same manner as the interior of the restoration area. These perimeters should be managed to minimize the spread of

exotic species. The perimeter of Area 2 received plug plantings of *V. adunca* in 2014 and native forb seed in spring 2015, and should be further managed for weeds and seeded with native fescue in 2016. The perimeter of Area 3/5 should be, at a minimum, mowed once annually to reduce weed seed set. Two mowings per year is preferred. If time and resources allow, this perimeter should be treated with herbicides and planted with aggressive native species to thwart exotic species colonization.

Finally, the viewing deck trail in Area 3 has a band of nectar species planted along its length that varies in width and is up to approximately 6 feet wide on a single side of the trail. Native nectar plants in this strip are well established, but several exotic species are still present, including introduced grasses, *H. radicata*, and *R. repens*. This area should be managed to reduce weed colonization in the adjacent restoration area. Spot herbicide or wiper treatments of *H. radicata* should be considered to control its spread, as should spot treatments of *R. repens* and *R. acetosella*. Mowing should be considered to manage thatch and prepare the strip for potential spring grass-specific herbicide use.

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