2016 Vegetation Monitoring at Herbert Farm & Natural Area: Phase I Restoration – Web version

3/29/2017

Summary report to the City of Corvallis and Oregon Department of Fish and Wildlife

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Institute for Applied Ecology

PREFACE

IAE is a non-profit organization whose mission is conservation of native ecosystems through restoration, research and education. IAE provides services to public and private agencies and individuals through development and communication of information on ecosystems, species, and effective management strategies. Restoration of habitats, with a concentration on rare and invasive species, is a primary focus. IAE conducts its work through partnerships with a diverse group of agencies, organizations and the private sector. IAE aims to link its community with native habitats through education and outreach.

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ACKNOWLEDGMENTS

This project has been funded by the Oregon Department of Fish and Wildlife through its Willamette Wildlife Mitigation Program.

Cover photograph: Herbert Farm and Natural Area. *Photo by Peter Moore.*

Special Note:
This report has been modified from its original format by removing maps and/or appendices that include information on the location of rare and sensitive species.

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2016 Vegetation Monitoring at Herbert Farm & Natural Area: Phase I Restoration – Web version

A SUMMARY REPORT TO THE CITY OF CORVALLIS AND OREGON DEPARTMENT OF FISH AND WILDLIFE

INTRODUCTION

Herbert Farm and Natural Area (HFNA) is a 221 acre property in Benton County, Oregon at the southern edge of Corvallis. The property was purchased by the City of Corvallis (the City) in 2000. Oregon Department of Fish and Wildlife (ODFW) holds a conservation easement that preserves and protects the conservation values of the property in perpetuity as a Bonneville Power Administration (BPA) mitigation site for the Willamette Basin federal hydro-electric dams and reservoirs. HFNA is bordered by Marys River and Muddy Creek and has remnant flood channels and swales that were formed during previous flood events (Figure 1).

The property includes a variety of upland prairie, wet prairie, oak and riparian habitats. Until 2011, approximately 173 acres of HFNA were in agricultural production, primarily for grain or seed production (e.g., winter wheat, annual ryegrass). As of 2014, 84 acres of agricultural use were restored to natural habitats (Menke et al. 2013, unpubl. data). Some areas in the southwest portion of HFNA had never been cultivated and retained diverse natural features (City of Corvallis 2011).

HFNA supports a diversity of rare plant species in remnant habitat areas. The site contains small populations of Kincaid's lupine (*Lupinus oreganus*) and Nelson's checkermallow (*Sidalcea nelsoniana*), two species federally listed as threatened. It also includes peacock larkspur (*Delphinium pavonaceum*) and thin-leaved peavine (*Lathyrus holochlorus*), two federal species of concern (Figure 2). Peacock larkspur is also listed by the State of Oregon as endangered. Previous rare plant surveys were conducted in 2006 (Salix Associates 2008), 2009 (Benton County 2010) and 2013 (Menke and Moore 2013).

Also of importance at HFNA is a nesting area for streaked horned larks (*Eremophila alpestris strigata*), a species federally listed as threatened. It has been recorded nesting along Herbert Avenue (Pacific Wildlife Research 2007, City of Corvallis 2011), utilizing a seasonally inundated

swale in the eastern part of HFNA (R. Moore, Oregon State University, pers. comm. 2014) and observed in nearby restoration areas in 2014-2016 (Moore 2015, 2016).

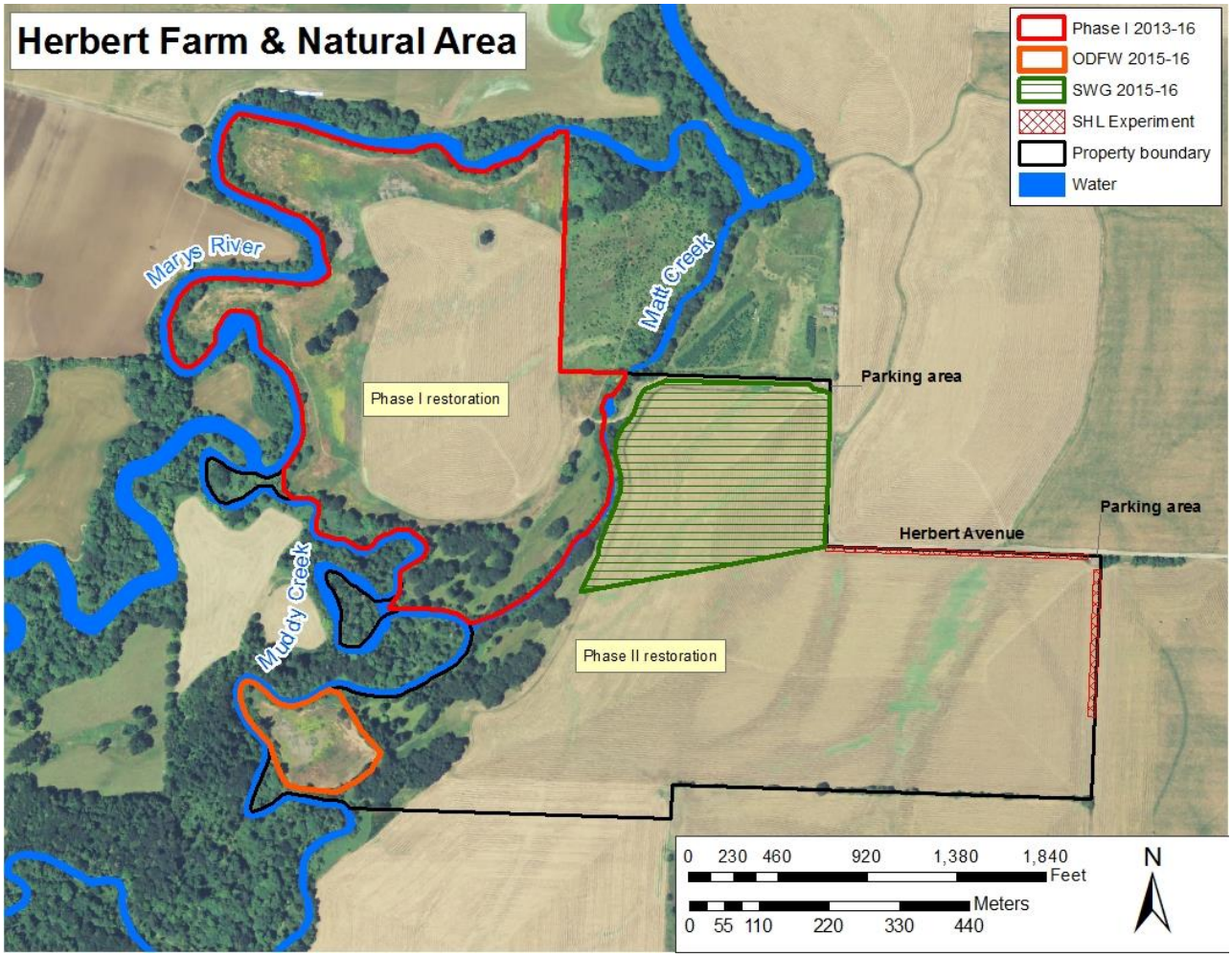

Figure 1. Phase I and II restoration areas of Herbert Farm and Natural Area. In addition, the map shows current funding sources for several restoration sub-units: Oregon Department of Fish and Wildlife (ODFW) Phase I 2013-2016 (red) and 2015-2016 (orange), U.S. Fish and Wildlife's State Wildlife Grant (SWG) 2015-2016 (green lined), and the U.S. Fish and Wildlife-funded streaked horned lark (SHL) experiment (maroon cross-hatched).

Figure 2. Rare plant species at HFNA. Clockwise from top left: thin-leaved peavine (*Lathyrus holochlorus*), peacock larkspur (*Delphinium pavonaceum*), Kincaid's lupine (*Lupinus oreganus*), and Nelson's checkermallow (*Sidalcea nelsoniana*). Photos by IAE staff.

Habitat restoration

A management plan for HFNA was prepared by the City and its partners to guide management of the site over a 10 year period (City of Corvallis 2011). In 2013, the Institute for Applied Ecology (IAE) developed the Herbert Farm and Natural Area Restoration Plan (Phase I) (Menke et al. 2013), which is guiding restoration of riparian, woodland, upland and wet prairie areas in the Phase I (western) area of HFNA, bounded by Marys River, Muddy Creek and Matt Creek (Figure 1).

The City receives state and federal permit coverage to work with protected plant species at HFNA as a Prairie Conservation Area through the Benton County Habitat Conservation Plan (HCP)(Benton County 2010). Restoration in areas with the protected plant species is also guided by the U.S. Fish and Wildlife Service (USFWS) PROJECTS Biological Opinion (USFWS 2015), since the City is enrolled in the USFWS Partners for Fish and Wildlife Program.

Restoration actions conducted since 2012 are summarized in Appendix 1. Site preparation occurred in 2013 and 2014. A 37-acre agriculture field was converted to upland prairie and wet prairie swales by seeding native forbs and grasses in fall of 2014 and 2015. Fallow grassland (29 acres) was converted to riparian trees and shrubs, including 22 acres of high density riparian species plantings (1900 stems per acre and a tree to shrub ratio of 1:3) and seven acres of low density riparian species plantings (350 stems per acre and 3:1 tree to shrub ratio). Approximately 44,000 trees and shrubs were planted in winter 2015 and an additional 14,000 were planted in 2016. Existing areas of wet prairie (two acres), upland prairie (two acres) and woodland (four acres) were enhanced to varying degrees.

Habitat restoration in the southeast portion of the Phase I restoration area (Figure 1) has included the following rare plant population augmentation efforts:

- 1,500 Nelson's checkermallow rhizomes in 2013
- 7.5 lbs of Nelson's checkermallow seed in 2015
- 483 plugs of Kincaid's lupine in spring of 2016
- 0.5 lbs of Kincaid's lupine seed in fall of 2016
- 294 plugs of peacock larkspur in fall of 2016

Vegetation monitoring

To maintain the permit coverage for habitat restoration in areas with protected plant species from the Benton County HCP, the City is required to complete effectiveness monitoring to provide data for adaptive management. The required monitoring is described in the HCP (Benton County 2010) and summarized here. The objectives of monitoring at HFNA are to:

- Locate and map invasive species, assess success of invasive species control efforts;
- Evaluate the establishment rates of high and low density riparian planting strategies, assess the intensity of wildlife browse to plantings, and determine the effectiveness of vegetation control (invasive and otherwise) in riparian planting areas;

- Track rare plant species establishment and persistence in restored and enhanced habitats, as required for HCP Prairie Conservation Area monitoring (Benton County 2010);
- Assess the effects of habitat restoration, management and enhancement tools (e.g., mowing, prescribed burning), on plant community composition.

Baseline vegetation monitoring was completed by IAE in 2013 (Menke and Moore 2013). Effectiveness monitoring was conducted by IAE in 2016. This report summarizes the results of the 2016 monitoring efforts, which included site wide weed surveys, vegetation plots in the riparian zone, surveys of threatened species, and photographs at previously established photo points.

Report objectives

The objectives of this report are to summarize the response of vegetation, as of 2016, to habitat restoration efforts at HFNA, including:

- Cover of invasive plant species;
- Establishment of riparian vegetation in high and low density plantings;
- Rare plant population dynamics; and
- Observations from photo point analysis.

MONITORING FIELD METHODS

Monitoring occurred over nine days between May 20 and June 24, 2016. Weed and rare plant surveys were completed by one IAE staff member over seven of those days, and the riparian plot monitoring was completed by two IAE staff over the remaining two days.

Monitoring methods are summarized in Table 1 and follow those outlined by IAE (Menke and Moore 2013), with the addition of 50 meter (m) transects in the riparian areas and photo points in all areas. Prairie habitat condition vegetation monitoring is scheduled to occur in 2017 (Table 1).

Invasive plant surveys

The following species were mapped using a *Nautiz X7* Handheld with *ArcPad 10* GIS software. Patches were recorded when multiple plants were found within relatively close proximity to each other.

- Himalayan/European blackberry: *Rubus armeniacus* and *Rubus vestitus*
- Reed canarygrass: *Phalaris arundinacea*
- False brome: *Brachypodium sylvaticum*
- Meadow knapweed: *Centaurea pratensis*
- St. Johnswort: *Hypericum perforatum*
- Tansy ragwort: *Senecio jacobaea*
- Thistle: *Cirsium arvense* and *Cirsium vulgare*
- Scotch broom: *Cytisus scoparius*
- Field bindweed: *Convolvulus arvensis*

Table 1. Vegetation monitoring methodology and schedule for Herbert Farm and Natural Area's Phase I restoration area (modified from Menke and Moore 2013).

Habitat (acres)	Monitoring Type	Layout	Monitoring Methods	Year
All areas	Invasive plant surveys	Walk through entire Phase 1 area.	Locate and map invasive species.	2013, 2016
Riparian, low density (7 acres), high density (21 acres)	Riparian, planting success and habitat condition	Fifteen 5m x 5m randomly-placed plots in each of high and low density areas; survival count on 50m transects.	Plots: Tree/shrub canopy cover by species. Densitometer at chest height to estimate shading. Note frequency of severe graze/browse. Percent cover of invasives by species (e.g., blackberry), all exotics, plant litter & bare ground. Count and identify trees and shrubs on transects.	2013, 2016
Restored prairie (37 acres)	Prairie plant community composition	Fifteen 2m x 2m plots, random placement throughout zone.	Plots: Percent cover by all species, bare ground and plant litter.	2013, 2017
Upland prairie (2 acres)	Prairie plant community composition ; rare species census	Five 2m x 2m plots, random placement throughout zone. Walk through area for census.	Census of rare species (entire area). Plots: Percent cover by all species, bare ground and plant litter.	2013, 2016
Wet prairie (2 acres)	Prairie plant community composition; rare species census	Five 2m x 2m plots, random placement throughout zone. Walk through area for census.	Census of rare species (entire area). Plots: Percent cover by all species, bare ground and plant litter.	2013, 2017
Woodland (4 acres)	Rare species census	Walk through area for census.	Census of Nelson's checkermallow.	2013, 2016

Riparian trees, shrubs and vegetation

Plots

In both 2013 and 2016, vegetation attributes were measured in 15 randomly-placed (via x and y coordinates) 5 m x 5 m plots in both the low density and high density riparian areas (Figure 3, Appendix 2). Within plots, percent foliar cover of native trees, native shrubs, invasive plants, non-native plants (total) and plant litter was estimated. A densitometer, held at breast height (1.37 m), was used to estimate the amount of shading by the tree and shrub canopy.

Figure 3. Riparian vegetation monitoring plot locations within high density and low density riparian planting zones at Herbert Farm and Natural Area.

Transects

In order to further assess the survival of tree and shrub plantings, 50 m transects were added throughout the riparian planting area in 2016. Starting from the outside edge of each riparian vegetation plot, transects were run along the planted row nearest to the center of each riparian vegetation plot, following the row in the direction in which there was most space (Figure 4). Each surviving tree and shrub along the transect was counted and identified to species.

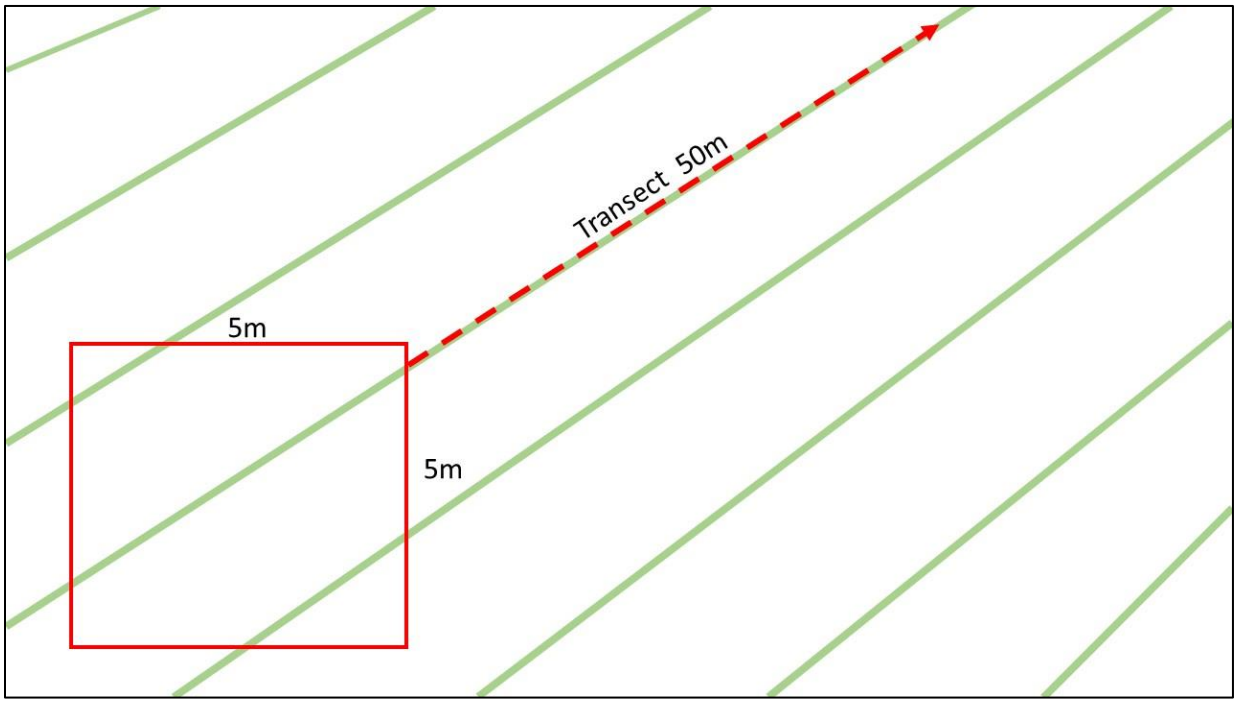

Figure 4. Diagram of transect placement, relative to 5 m x 5 m riparian monitoring plot.

In addition, total counts of trees and shrubs were made in a subsample of riparian plantings during 2015 and 2016.

Rare plants

Peacock larkspur, Nelson's checkermallow, and Kincaid's lupine populations were censused. Individual plants of peacock larkspur and Nelson's checkermallow were counted. Kincaid's lupine was measured in square meters of lupine foliar cover, the standard metric for this species as described in the Benton County HCP (2010) and the USFWS Recovery Plan for Prairie Species of Western Oregon and Southwest Washington (2010). In addition, thin-leaved peavine was mapped and stems were counted as a measure of abundance. (Since this species can spread rhizomatously, it is difficult to determine the actual number of individuals.)

Photo points

Ten photo points were established throughout the restoration area in 2014 to repeat photographs taken in 2012-2013, including two points specifically placed along an eroding bend of Marys River (Figure 5). An additional two points were added in 2015. All points were mapped in GIS,

and ten of the points were marked with white PVC poles. At each point, photos were taken in up to four directions at least once per year (Appendices 2 and 3).

Figure 5. Herbert Farm and Natural Area photo point locations.

MONITORING RESULTS

Invasive plant surveys

A comparision of the distribution of invasive plant species in 2013 and 2016 is shown in Figure 6. During the interval between 2013 and 2016, extensive weed treatments were conducted at HFNA, resulting in a reduction in the cover of Himalayan blackberry (~87% reduction), reed canarygrass (~50% reduction), and bull thistle (75% reduction) (Table 2, Figure 6). Reductions are most apparent along the river terrace, where dense thickets of blackberry and reed canarygrass were present in 2013. Canada thistle was the most widely distributed species in the 2016 survey, maintaining a similar area to that which it covered in 2013. Two small patches of tansy ragwort were found in the northwest corner of the restoration prairie in 2016. Bindweed and St. Johnswort were potentially under-represented in the 2016 survey, since they were yet to flower and were difficult to spot amongst other vegetation. Meadow knapweed, Scotch broom and false brome were not observed in the Phase I area in 2016. Other potentially problematic non-native weeds observed on site include sow thistle, prickly lettuce and stinking chamomile.

Table 2. Comparison of invasive species cover (m^2) in 2013 (pre-restoration) and 2016 (restoration in progress.

Invasive Species Cover (Square meters)		
SPECIES	**2013**	**2016**
Canada thistle	24,316	24,370
Bull thistle	1951	454
Field bindweed	N/A	571
St. Johnswort	3,396	270
Reed Canarygrass	23,139	8,155
Himalayan blackberry	44,445	5,684
Tansy ragwort	174	19
Total	**97,421**	**39,523**

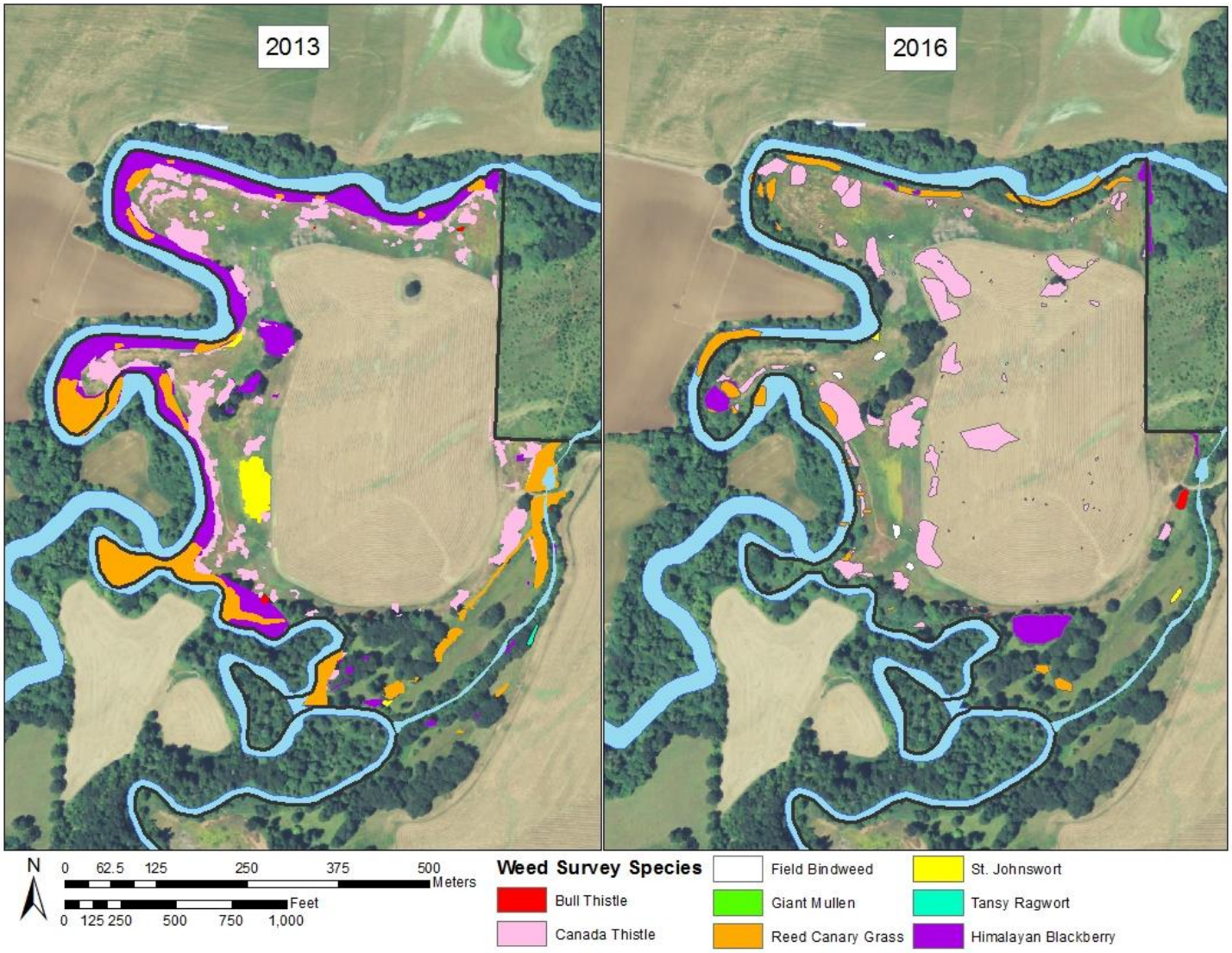

Figure 6. Invasive species locations in the Phase I restoration area of Herbert Farm and Natural Area in 2013 (left) and 2016 (right). Note the southwestern lobes of Muddy Creek were not surveyed, as they were not part of Phase I restoration area.

Riparian trees, shrubs and vegetation

Riparian vegetation

Invasive species cover within the riparian planting areas decreased between pre-planting levels in 2013 and 2016 conditions. In high density areas, invasive species cover decreased from an average of 10% to 4%, and in low density areas, cover declined from 3.5% to less than 1% (Figure 7). This is presumably as a result of herbicide treatments and seeding of the riparian planting area with native grasses.

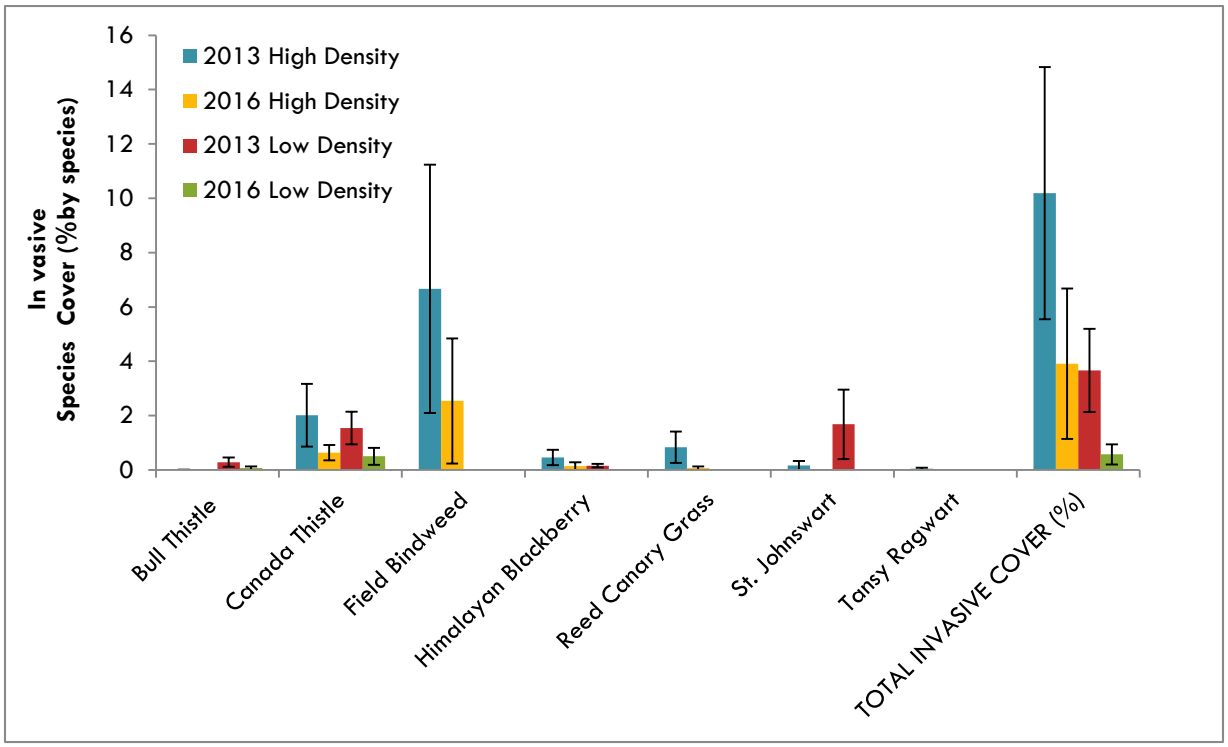

Figure 7. Average (± standard error) invasive species cover within high and low density riparian planting areas at Herbert Farm Natural Area, in 2013 and 2016.

Blackberry, bindweed, Canada thistle and reed canarygrass were most abundant 2013, whereas in 2016, bindweed and Canada thistle were most abundant. The cover of bare ground also decreased from 91% in 2013 (for both high and low density plots) to 22% for high density plots and 12.1% in low density plots in 2016 (Table 3). Gramanoids, which represented less than 10% of ground cover in both high and low density areas in 2013, made up more than half of the ground cover in both high and low density areas in 2016. This is likely due to the seeding of native grasses that occurred in fall 2014. The percentage of forbs in the ground cover decreased from 2013 in high density area, while increasing in low density areas.

Table 3: Average ground cover for 5 m x 5 m plots in high and low riparian planting zones.

Year	Planting Density	Forb Cover (%)	Graminoid Cover (%)	Bare Ground Cover (%)
2013	High Density	58	7.3	90.7
2016	High Density	19	51.3	22.2
2013	Low Density	1.1	6.7	91.4
2016	Low Density	14.3	72.3	12.1

Trees and shrubs

Average tree cover was 0.9% in 2013, with an increase to 3% by 2016 in high and low density combined. Shrub cover increased from 0.3% to 2.9% on average (Figures 8 and 9). Riparian trees and shrubs planted in 2015 and 2016 still have low vegetation cover, since plants are still small and generally below chest height. Big leaf maple (*Acer macrophyllum*), Oregon ash (*Fraxinus latifolia*), and Oregon white oak (*Quercus* garryana) were the most common surviving tree species in 2016, averaging 1.5, 6.7 and 2.3 trees respectively per 50m transect. Pacific ninebark (*Physocarpus capitatus*), Pacific willow (*Salix lucida*), Douglas spiraea (*Spiraea douglasii*) and snowberry (*Symphoricarpos albus*) were the most common shrub species in 2016, averaging 3.2, 1.8, 2.6 and 2.5 shrubs per 50m transect. Planted tree and shrub survival in high and low density riparian rows are summarized for 2015 in Table 4. Survival was low due a late planting date (3/19/15) and a summer drought in 2015. Approximately 25% more trees and shrubs were inter-planted in the rows on 2/12/16 and a better growing season in 2016 resulted in higher survival. By November 2016 the stem count was 61% of the original number planted.

Densiometer data will be presented in the next monitoring report- at this time, trees and shrubs are too small for this sampling to illustrate differences between treatments.

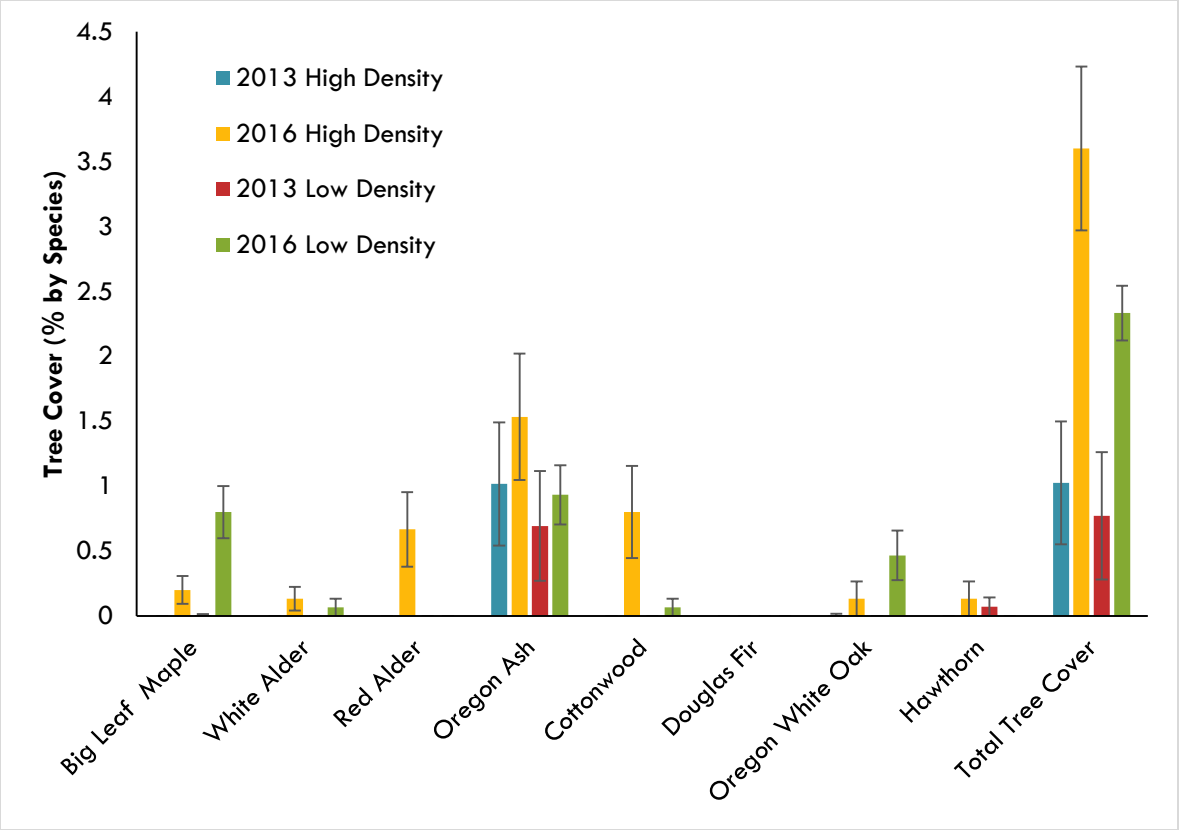

Figure 8. Average (± standard error) tree cover within high and low density riparian restoration areas.

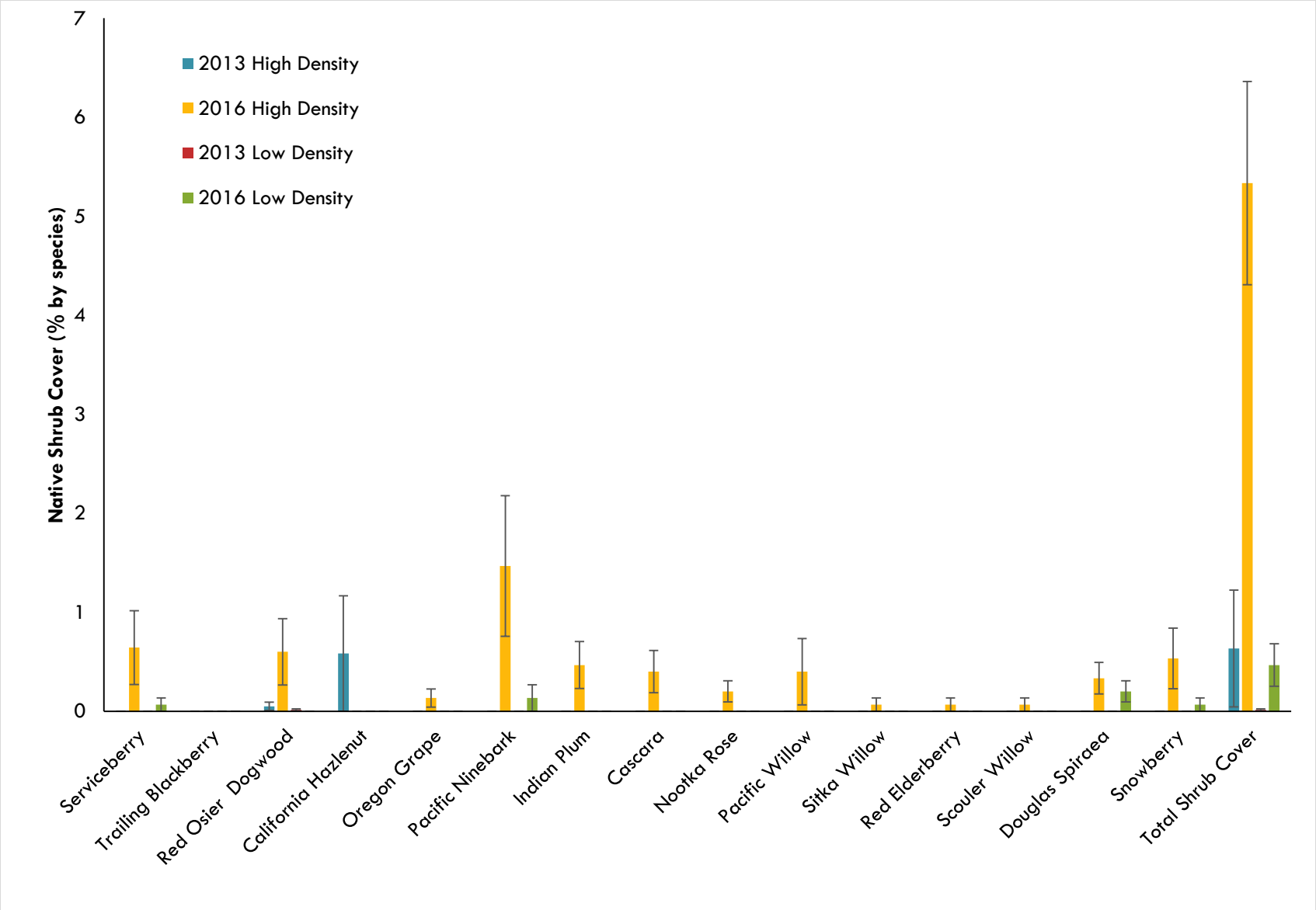

Figure 9. Average (± standard error) shrub cover within high and low density riparian restoration areas.

Table 4: Tree and shrub survival in high and low density riparian vegetation plantings during 2015.

Planting Density	Monitoring Date	Live Stems Counted (subsample)	% survival
Low	4/21/2015	264	99%
High	4/22/2015	691	97%
Low	6/30/2015	260	98%
High	6/30/2015	654	95%
Low	7/31/2015	219	83%
High	7/31/2015	422	61%
Low	11/4/2015	145	55%
High	11/4/2015	263	38%

Rare plants

Table 5 and Appendix 4 summarize the results of rare plant monitoring in both 2013 and 2016. Of the 17.83 m^2 of Kincaid's lupine found in 2016, 1.74 m^2 are attributed to supplemental plantings in 2016.

Although mixed in distribution, the Nelson's checkermallow were primarily found in the supplemental planting area along the wetland prairie, though incidental individuals were found elsewhere. The larkspur was within the previously documented areas mapped in the HFNA management plan. Kincaid's lupine was found within previously documented area in addition to two planting sites that were placed to the west along the same treeline.

Table 5. Rare plant species at HFNA in 2013 and 2016.

Rare Species Abundance				
Year	**Peacock larkspur (# individuals)**	**Nelson's checkermallow (# individuals)**	**Thin-leaved peavine (# stems)**	**Kincaid's lupine (m^2)**
2013	95	7	n/a	10
2016	233	222	20	17.83

Photo points

See Appendix 2 for a list of photo point coordinates and Appendix 4 for a subset of the photo point images taken from 2013 through 2016.

Pre-restoration images in 2013 largely show ryegrass and mowed fields. Points in wet prairie and high density riparian areas show dominant areas of reed canary grass and Himalayan blackberry, respectively. Images from 2014 and 2015 depict transitional phases such as chemical fallow fields in prairie restoration areas, results of large scale herbicide treatments for reed canary grass and blackberry, and growth of grasses after broadcast seeding of native grasses. Results of restoration become increasingly visible in 2016. Prairie restoration area photos taken in 2016 show tarweed and farewell-to-spring blooming after they were seeded in fall of 2015. Likewise, 2016 photos from the riparian areas show young trees visible after the second year of planting and an early summer mowing.

CONCLUSIONS

Overall, invasive plant cover is declining in HFNA Phase I areas. Restoration work has been particularly effective in reducing blackberry and reed canarygrass cover. Canada thistle remains problematic. Continued work is needed to maintain the progress achieved during these initial restoration efforts, prevent infestations of new invasive species, and continue reducing existing invasive species cover.

Riparian tree and shrub establishment is progressing. Plants are still small, but overall, we are on track towards the target stem densities.

Rare plant populations are growing; these increases can be attributed to habitat improvements and active augmentation.

Restoration work in the Phase I and Phase II areas of HFNA will continue, as described in the overall Management Plan and the respective restoration plans for each area. Prairie habitat monitoring is scheduled to occur in spring 2017.

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APPENDIX 1: SUMMARY OF RESTORATION ACTIONS IN PHASE I AREAS OF HERBERT FARM & NATURAL AREA, 2012-2016

Year	Habitat	Riparian	Restoration prairie	Woodland	Wet Prairie	Upland Prairie
	acres	28	37	4	2	2
	Season					
2012	Summer (Jun-Aug)	Tractor mow		Tractor mow	Tractor mow	Tractor mow
2013	Spring (Mar-May)	Broadcast spray Monitor weeds	Monitor weeds	Monitor weeds & threatened species	Monitor weeds & threatened species	Monitor weeds & threatened species
	Summer (Jun-Aug)	Spot spray Skid steer mow	Final harvest	Tractor mow	Monitor threatened species Tractor mow	Monitor threatened species Tractor mow
	Fall (Sep-Nov)	Broadcast & Spot spray	Broadcast spray		Broadcast spray	Spot spray Plant Nelson's checkermallow rhizomes
2014	Spring (Mar-May)	Broadcast & Spot spray				
	Summer (Jun-Aug)	Skid steer mow	Broadcast spray	Tractor mow	Broadcast spray	Spot spray Tractor mow
	Fall (Sep-Nov)	Broadcast & Spot spray Seed broadcast	Tribal elder visit Broadcast spray Seed broadcast		Broadcast spray Seed broadcast	Spot spray
2015	Winter (Dec-Feb)	Cultural rescource survey	Cultural rescource survey	Cultural rescource survey	Cultural rescource survey	Cultural rescource survey
	Spring (Mar-May)	Plant trees & shrubs				
	Summer (Jun-Aug)	Circle, row & spot spray tractor & hand mow Hand water Hand weed	Broadcast spray Spot spray Hand weed		Spot spray	Spot spray
	Fall (Sep-Nov)	Hand mow	Seed drilled		Seed drilled	
2016	Winter (Dec-Feb)	Plant trees & shrubs				
	Spring (Mar-May)	Row spray Monitor weeds & threatened species	Monitor weeds & threatened species Spot spray	Monitor weeds & threatened species	Monitor weeds & threatened species	Plant Kincaid's lupine plugs Monitor weeds & threatened species
	Summer (Jun-Aug)	Circle & spot spray hand mow tractor mow	Spot spray Tractor mow	Girdle fir trees	Spot spray Monitor threatened species	Spot spray Monitor threatened species

APPENDIX 2: PHOTO POINT COORDINATES

Photo point (PP) and river bend photo point (RB) coordinates (projection is UTM WGS 1984; Figure 5) and direction of one to four photographs taken at each point (photos a-d).

Photopoint number	Latitude	Longitude	Direction of photo (degrees)			
			a	b	c	d
PP1	44.521444	-123.295944	186	304	342	84
PP2	44.520806	-123.295556	210	2	158	
PP3	44.519833	-123.296361	33	205	314	
PP4	44.520139	-123.298833	289	355	100	256
PP5	44.5205	-123.301167	24	80	105	245
PP6	44.521833	-123.301056	331	24	90	160
PP7	44.523167	-123.30175	85	116	170	255
PP8	44.524139	-123.296167	180	208	275	326
PP9	44.524167	-123.300028	195	330	15	95
PP10	44.522139	-123.299861	250	330	14	75
RB1	44.523278	-123.300944	45			
RB2	44.523333	-123.300583	270	30	140	180

APPENDIX 3: PHOTO POINT IMAGES

Up to four photographs are taken at each photo point (Appendix 2). A subset of images is provided here. Other photographs are stored at IAE.

Photo point 1: Restoration Prairie (37 acres)

Photo point 1b. April 24, 2013: Ryegrass field prior to conversion to prairie.

Photo point 1b. June 5, 2015: First growing season after broadcast seeding with native forbs and Roemer's fescue in fall of 2014.

Photo point 1b. April 21, 2015: Former farmed field after two years of herbicide treatment.

Photo point 1b. July 1, 2016: Second growing season after seeding with native forbs and grasses with a no-till drill in fall 2015. Showing abundant common madia (tarweed), yarrow, farewell to spring and grand collomia in this view from the south end of the 37 acre prairie.

Photo point 2: Wet Prairie (2 acres)

Photo point 2a. May 10, 2013: Reed canarygrass dominated vegetation adjacent to wet praire, prior to herbicide treatment.

Photo point 2a. June 5, 2015: After broadcast seeding with forbs and grasses in fall 2014. Non-native weeds such as prickly lettuce are visible in the foreground.

Photo point 2a. September 13, 2013: After first herbicide treatment of reed canarygrass.

Photo point 2a. May 31, 2016: After no-till drilling of native forbs and grasses in fall 2015. A mixture of native (e.g., meadow barley) and non-native grasses is visible in the foreground.

Photo point 3: Wet prairie (2 acres)

Photo point 3a. September 18, 2012: After the annual mowing by The City.

Photo point 3a. June 5, 2015: After second year of herbicide treatment and broadcast seeding of forbs and grasses in fall 2014.

Photo point 3a. April 15, 2014: After first year of broadcast herbicide treatments.

Photo point 3a. May 31, 2016: After no-till drill seeding of native forbs and grasses in fall 2015.

Photo point 3: Upland prairie (2 acres)

Photo point 3b. September 18, 2012: After annual mowing by The City.

Photo point 3b. June 5, 2015. Oxeye daisy flowers dominate the view.

Photo point 3b. April 15, 2014: After two years of minor spot-spraying for reed canarygrass. Camas flowers are visible amongst the grasses.

Photo point 3b. May 31, 2016. After not being mowed in 2015, some Nootka rose and other vegetation is becoming evident in the foreground.

Photo point 4: Restoration prairie (37 acres)

Photo point 4b. April 15, 2014: After first year of broadcast herbicide treatments.

Photo point 4b. June 5, 2015: After broadcast seeding of native forbs and Roemer's fescue in fall 2014. Recruitment was poor initially leaving open ground for invasion by invasive weeds such as prickly lettuce, sowthistle, stinking chamomile and cudweed.

Photo point 4b. May 31, 2016: After drilling with native forbs and grasses in fall 2015 there was good recruitment but also infestation of sinking chamomile.

Photo point 4b. July 1, 2016: Later the same season showing good dense growth of common madia, mix of other annuals such as farewell-to-spring and infestation of stinking chamomile.

Photo point 4: Low density riparian (7 acres)

Photo point 4d. April 24, 2013: Fallow grassland and riparian edge prior to treatments.

Photo point 4d. April 21, 2015: After two years of herbicide treatments, broadcast seeding of grasses in fall 2014 and planting of riparian trees and shrubs in low density rows in March 2015. Trees were planted at approximately 350 stems/acre (rows 12 feet apart and 10 feet between plants within rows) in March 2015.

Photo point 4d. May 31, 2016: spring grass growth.

Photo point 4d. July 1, 2016: Rows of Low density riparian trees and shrubs, after the second planting in February 2016 (interplanting in spaces for dead trees) and after mowing in June.

Photo point 5: High density riparian (22 acres)

Photo point 5a. April 24, 2013: Blackberry thicket on riparian margin of Marys River.

Photo point 5a. April 15, 2014: After one year of treatments, including skid steer mowing and herbicide.

Photo point 5a. June 5, 2015: After sowing of grasses in fall 2014 and planting of high density riparian rows in March 2015. Approximately 1900 stems were planted per acre in 22 acres (rows were 6.5 feet apart and plants were 3.5 feet apart within rows).

Photo point 5a. July 1, 2016: After second season of planting riparian trees and shrubs in February 2016 (inter-planting in gaps created by dead trees), and after mowing in June.

Photo point 6: High density riparian (22 acres)

Photo point 6a. June 6, 2013: Riparian margin of blackberry and reed canarygrass along Marys River being mowed by skid steer.

Photo point 6a. June 5, 2015: After second year of herbicide treatment, sowing of grasses in fall 2014 and planting of high density trees and shrubs in March 2015.

Photo point 6a. April 15, 2014: After one year of herbicide treatment.

Photo point 6a. July 1, 2016: After second year of planting trees and shrubs in February 2016, and after mowing in June.

Photo point 6: High density riparian (22 acres)

Photo point 6b. April 15, 2014: After one year of herbicide treatment.

Photo point 6b. May 31, 2016: After second year of planting riparian trees and shrubs in February 2016, and line spraying of rows in spring.

Photo point 6b. June 5, 2015: After second year of herbicide treatment, sowing of grasses in fall 2014 and planting of high density trees and shrubs in March 2015.

Photo point 6b. July 1, 2016: After second year of planting trees and shrubs in February 2016, and after mowing in June.

Photopoint 7: High density riparian (22 acres)

Photo point 7a. September 13, 2013: Blackberry regrowth after mowing, prior to herbicide treatment.

Photo point 7a. April 15, 2014: After one year of mowing and herbicide treatment.

Photo point 7a. June 5, 2015: After second year of herbicide treatment, sowing of grasses in fall 2014 and planting of riparian trees and shrubs in February 2015.

Photo point 7a. July 1, 2016: riparian edge after two years site preparation and two years planting trees and shrubs. New trees can be seen in the mowed rows.

Photo point 7: High density riparian (22 acres)

Photo point 7c. April 15, 2014: After one year of mowing and herbicide treatment.

Photo point 7c. April 21, 2015: After second year of herbicide treatment, sowing of grasses in fall 2014 and planting of riparian trees and shrubs in February 2015.

Photo point 7c. May 31, 2016: After second year of planting riparian trees and shrubs in February 2016, and line spraying of rows in spring.

Photo point 7c. July 1, 2016: After riparian edge after two years site preparation and two years planting trees and shrubs. New trees can be seen in the mowed rows.

Photo point 8: Restoration Prairie (37 acres)

Photo point 8b. April 24, 2013: Ryegrass field prior to conversion to prairie.

Photo point 8b. April 15, 2015: Former farmed field after one year of herbicide treatment.

Photo point 8b. June 5, 2015: First growing season after broadcast seeding with native forbs and Roemer's fecue in fall of 2014. Recruitment of natives was poor in the northern part of the prairie and space was taken by annual weeds such as sow thistle prickly lettuce and cudweed.

Photo point 8b. July 1, 2016: Second growing season after seeding with native forbs and grasses with a no-till drill in fall 2015. Showing more recruitment of natives such as yarrow, farewell to spring and grand collomia in this view or the north end of the 37 acre prairie, but including dense non-native stinking chamomile.

Photo point 9: Low density riparian (7 acres)

Photo point 9a. April 21, 2015: After second year of herbicide treatment, sowing of grasses in fall 2014 and planting of riparian trees and shrubs in February 2015.

Photo point 9a. May 31, 2016: After second year of planting riparian trees and shrubs in February 2016, and line spraying of rows in spring.

Photo point 9a. June 5, 2015: After circle spraying low density riparian rows.

Photo point 9a. July 1, 2016: After riparian edge after two years site preparation and two years planting trees and shrubs. New trees can be seen in the mowed rows.

Photo point 9: Restoration prairie (37 acres)

Photo point 9d. April 21, 2015: Early in the first growing season after broadcast seeding with native forbs and Roemer's fecue in fall of 2014.

Photo point 9d. June 5, 2015: Recruitment of natives was poor in the northern part of the prairie and space was taken by annual weeds such as sow thistle and prickly lettuce.

Photo point 9d. May 31, 2016: Second growing season after seeding with native forbs and grasses with a no-till drill in fall 2015. This northern sector of the 37 acre field showing more recruitment of natives but dominated by non-native weeds such as sow thistle, prickly lettuce and stinking chamomile.

Photo point 9d. July 1, 2016: Weedy area dominated by stinking chamomile.

Photo point 10: Low density riparian (7 acres)

Photo point 10a. April 21, 2015: After second year of herbicide treatment, sowing of grasses in fall 2014 and planting of riparian trees and shrubs in February 2015. Colored flags mark the low density rows, approximately 12 feet apart.

Photo point 10a. June 5, 2015: After circle spraying low density riparian rows.

Photo point 10a. May 31, 2016: After second year of planting riparian trees and shrubs in February 2016, and circle spraying of rows in spring.

Photo point 10a. July 1, 2016: After mowing in June. Note the taller bigleaf maple in the sequence of photographs.

Photo point River Bend 1

Photo point RB1. December 7, 2012: Marys River at high water in winter.

Photo point RB1. April 15, 2014: Eroded river bank of Marys River. Restoration treatments occurred on the riparian terrace but not on the river bank.

Photo point RB1. July 1, 2016: Eroded river bank of Marys River with high density riparian trees visible in the background.

Photo point River Bend 2

Photo point RB2. December 7, 2012: Marys River at high water in winter.

Photo point RB2. April 15, 2014: Eroded river bank of Marys River. Restoration treatments occurred on the riparian terrace seen to the left of the view.

Photo point RB2. July 1, 2016: Reed canarygrass in the untreated area of the river bank.

APPENDIX 4: THREATENED AND ENDANGERED SPECIES LOCATIONS

Map has been removed in this web version of the report.

Figure A4. 2016 locations of rare plants covered in the Benton County Habitat Conservation Plan at Herbert Farm and Natural Area, including Kincaid's lupine (*Lupinus oreganus*), peacock larkspur (*Delphinium pavonaceum*), and Nelson's checkermallow (*Sidalcea nelsoniana*).